WT1800
Precision Power Analyzer
USER'S MANUAL

Features Guide

YOKOGAWA
Yokogawa Meters & Instruments Corporation

IM WT1801-01EN
2nd Edition

Thank you for purchasing the WT1800 Precision Power Analyzer. This manual contains useful information about the features of the WT1800. To ensure correct use, please read this manual thoroughly before beginning operation.
After reading the manual, keep it in a convenient location for quick reference whenever a question arises during operation. The following manuals, including this one, are provided as manuals for the WT1800. Please read all the manuals.

Manual Title	Manual No.	Description
WT1800 Precision Power Analyzer Features Guide	IM WT1801-01EN	This manual. The supplied CD contains the PDF file of this manual. This manual explains all the WT1800 features other than the communication interface features.
WT1800 Precision Power Analyzer User's Manual	IM WT1801-02EN	The supplied CD contains the PDF file of this manual. The manual explains how to operate the WT1800.
WT1800 Precision Power Analyzer Getting Started Guide	IM WT1801-03EN	The manual explains the handling precautions and basic operations of the WT1800 and provides an overview of its features.
WT1800 Precision Power Analyzer Communication Interface User's Manual	IM WT1801-17EN	The supplied CD contains the PDF file of this manual. The manual explains the WT1800 series communication interface features and instructions on how to use them.

Notes

- The contents of this manual are subject to change without prior notice as a result of continuing improvements to the instrument's performance and functionality. The figures given in this manual may differ from those that actually appear on your screen.
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1 Items That This Instrument Can Measure

The items that you can measure with this instrument are listed below. For details about how the values of the measurement functions are determined, see appendix 1 in the getting started guide, IM WT1801-03EN. For explanations of the terms measurement function, input element, and wiring unit, see “What Is a Measurement Function?”

▶ Click here.

The input elements and wiring units referred to in each measurement function table are listed below. However, the input elements and wiring units that you can measure vary depending on how many input elements are installed in the WT1800.

- Input elements: Element1, Element2, Element3, Element4, Element5, Element6
- Wiring units: ΣA, ΣB, ΣC

Measurement Functions Used in Normal Measurement

Voltage

Function	Description	Input Element	Wiring Unit
Urms	True rms voltage	Yes	Yes
Umn	Rectified mean voltage calibrated to the rms value	Yes	Yes
Udc	Simple voltage average	Yes	Yes
Urmn	Rectified mean voltage	Yes	Yes
Uac	AC voltage component	Yes	Yes
U+pk	Maximum voltage	Yes	No
U−pk	Minimum voltage	Yes	No
CfU	Voltage crest factor	Yes	No

Current

Function	Description	Input Element	Wiring Unit
Irms	True rms current	Yes	Yes
Imn	Rectified mean current calibrated to the rms value	Yes	Yes
Idc	Simple current average	Yes	Yes
Irmn	Rectified mean current	Yes	Yes
Iac	AC current component	Yes	Yes
I+pk	Maximum current	Yes	No
I−pk	Minimum current	Yes	No
CfI	Current crest factor	Yes	No

Power

Function	Description	Input Element	Wiring Unit
P	Active power	Yes	Yes
S	Apparent power	Yes	Yes
Q	Reactive power	Yes	Yes
λ	Power factor	Yes	Yes
Φ	Phase difference	Yes	Yes
Pc	Corrected Power	Yes	Yes
P+pk	Maximum power	Yes	No
P−pk	Minimum power	Yes	No

Frequency

Function	Description	Input Element	Wiring Unit
fU	Voltage frequency	Yes	No
fI	Current frequency	Yes	No
fPLL1	Frequency of PLL1[1]	No	No
fPLL2	Frequency of PLL2[2]	No	No

1 On models with the harmonic measurement option or the simultaneous dual harmonic measurement option.

2 Only on models with the simultaneous dual harmonic measurement option.

Integrated Power (Watt hours)

Function	Description	Input Element	Wiring Unit
Time	Integration time	Yes	No
WP	Sum of positive and negative watt hours	Yes	Yes
WP+	Sum of positive P values	Yes	Yes
WP−	Sum of negative P values	Yes	Yes
q	Sum of positive and negative ampere hours	Yes	Yes
q+	Sum of positive I values	Yes	Yes
q−	Sum of negative I values	Yes	Yes
WS	Volt-ampere hours	Yes	Yes
WQ	Var hours	Yes	Yes

Efficiency

Function	Description
η1 to η4	Efficiency

User-Defined Functions

Function	Description
F1 to F20	User-defined functions

User-defined events

Function	Description
Ev1 to Ev8	User-defined events

Harmonic Measurement Functions (Option)

Function	Description	Input Element	Wiring Unit
U(k)	Rms voltage of harmonic order k	Yes	Yes
I(k)	Rms current of harmonic order k	Yes	Yes
P(k)	Active power of harmonic order k	Yes	Yes
S(k)	Apparent power of harmonic order k	Yes	Yes
Q(k)	Reactive power of harmonic order k	Yes	Yes
λ(k)	Power factor of harmonic order k	Yes	Yes
Φ(k)	Phase difference between the voltage and current of harmonic order k.	Yes	No
ΦU(k)	Phase difference between the fundamental signal, U(1), and harmonic voltage U(k)	Yes	No
ΦI(k)	Phase difference between the fundamental signal, I(1), and harmonic current I(k)	Yes	No
Z(k)	Impedance of the load circuit	Yes	No
Rs(k)	Series resistance of the load circuit	Yes	No
Xs(k)	Series reactance of the load circuit	Yes	No
Rp(k)	Parallel resistance of the load circuit	Yes	No
Xp(k)	Parallel reactance of the load circuit	Yes	No
Uhdf(k)	Harmonic voltage distortion factor	Yes	No
Ihdf(k)	Harmonic current distortion factor	Yes	No
Phdf(k)	Harmonic active power distortion factor	Yes	No
Uthd	Total harmonic voltage distortion	Yes	No
Ithd	Total harmonic current distortion	Yes	No
Pthd	Total harmonic active power distortion	Yes	No
Uthf	Telephone harmonic factor of the voltage	Yes	No
Ithf	Telephone harmonic factor of the current	Yes	No
Utif	Telephone influence factor of the voltage	Yes	No
Itif	Telephone influence factor of the current	Yes	No
hvf	Harmonic voltage factor	Yes	No
hcf	Harmonic current factor	Yes	No
K−factor	K factor	Yes	No
ΦUi−Uj[1]	Phase difference between the fundamental voltage of element i, Ui(1), and the fundamental voltage of element j, Uj(1).	No	Yes
ΦUi−Uk[1]	Phase difference between Ui(1) and the fundamental voltage of element k, Uk(1)	No	Yes
ΦUi−Ii[1]	Phase difference between Ui(1) and the fundamental current of element i, Ii(1)	Yes[2]	Yes
ΦUj−Ij[1]	Phase difference between Uj(1) and the fundamental current of element j, Ij(1)	No	Yes
ΦUk−Ik[1]	Phase difference between Uk(1) and the fundamental current of element k, Ik(1)	No	Yes

1 i, j, and k are input element numbers. For example, when the number of input elements in wiring unit ΣA is six and the wiring system of elements 1, 2, and 3 is three phase, four wire, i is 1, j is 2, and k is 3. ΦUi – Uj represents ΦU1 – U2, the difference between the fundamental voltage signal of element 1, U1(1), and the fundamental voltage signal of element 2, U2(1). In the same way ΦUi – Uk, ΦUi – Ii, ΦUj – Ij, and ΦUk−Ik represent to ΦU1 – U3, ΦU1 – I1, ΦU2 – I2, and ΦU3 – I3, respectively.

2 Setting i to an input element, is the same as setting k to 1 in Φ(k).

Harmonic Measurement Function Orders

The harmonic orders that you can specify are indicated below.

Input Element Harmonic Measurement Functions

Measurement Function	Characters or Numbers in Parentheses			
	Total	0 (DC)	1	k
U( )	Yes	Yes	Yes	2 to 500
I( )	Yes	Yes	Yes	2 to 500
P( )	Yes	Yes	Yes	2 to 500
S( )	Yes	Yes	Yes	2 to 500
Q( )	Yes	Fixed at 0	Yes	2 to 500
λ( )	Yes	Yes	Yes	2 to 500
Φ( )	Yes	No	Yes	2 to 500
ΦU( )	No	No	No	2 to 500
ΦI( )	No	No	No	2 to 500
Z( )	No	Yes	Yes	2 to 100
Rs( )	No	Yes	Yes	2 to 100
Xs( )	No	Yes	Yes	2 to 100
Rp( )	No	Yes	Yes	2 to 100
Xp( )	No	Yes	Yes	2 to 100
Uhdf( )	No	Yes	Yes	2 to 500
Ihdf( )	No	Yes	Yes	2 to 500
Phdf( )	No	Yes	Yes	2 to 500
Uthd	Yes	No	No	No
Ithd	Yes	No	No	No
Pthd	Yes	No	No	No
Uthf	Yes	No	No	No
Ithf	Yes	No	No	No
Utif	Yes	No	No	No
Itif	Yes	No	No	No
hvf	Yes	No	No	No
hcf	Yes	No	No	No
K-factor	Yes	No	No	No

Functions with parentheses will produce different values depending on which of the following is contained in their parentheses.

- Total: Total value (The total value of all harmonic components from the minimum order to N.* For information about how the value is determined, see appendix 1 in the getting started guide, IM WT1801-03EN.)
- 0(DC): DC value
- 1: Fundamental harmonic value
- k: The value of any order from 2 to N.*

* N is the maximum measurable order. The maximum measurable harmonic order is the smallest of the three orders listed below.

- The specified maximum measurable harmonic order
- The value determined automatically according to the PLL source frequency (see section 6.4 in the getting started guide, IM WT1801-03EN)
- When the data update interval is 50 ms, the maximum measurable harmonic order is 100.

Wiring Unit Harmonic Measurement Functions (Σ functions)

Measurement Function	Characters or Numbers in Parentheses	
	Total	1
UΣ( )	Yes	Yes
IΣ( )	Yes	Yes
PΣ( )	Yes	Yes
SΣ( )	Yes	Yes
QΣ( )	Yes	Yes
λΣ( )	Yes	Yes

Functions with parentheses will produce different values depending on which of the following is contained in their parentheses.

- Total: Total value
- 1: Fundamental harmonic value

Delta Computation Functions (Option)

Function	Description
ΔU1 ΔU2 ΔU3 ΔUΣ ΔI ΔP1 ΔP2 ΔP3 ΔPΣ	The values returned by the delta computation functions vary depending on the specified delta computation type.

For details about delta computation functions, see “Delta Computation (Δ Measure; optional).”

▶ **Click here.**

Motor Evaluation Functions (Option)

Function	Description
Speed	Motor rotating speed
Torque	Motor torque
SyncSp	Synchronous speed
Slip	Slip (%)
Pm	Mechanical output of the motor (mechanical power)
EaU1 to 6*	Electrical angle: Phase angles of U1 to I6 with the falling edge of the signal received through the Z terminal of the motor evaluation function as the reference.
EaI1 to 6*	

* On models with the harmonic measurement option or the simultaneous dual harmonic measurement option.

Auxiliary Input Measurement Functions (Option)

Function	Description
Aux1	Auxiliary input 1
Aux2	Auxiliary input 2

High Speed Data Capturing Measurement Functios (Option)

- For the U and I of each input element and wiring unit: Select rms, mean, dc, or r-mean.
- The P of each input element and wiring unit
- Motor evaluation function (option) speed, torque, and Pm
- Auxiliary inputs (option) Aux1 and Aux2
- The maximum and minimum values of the above measurement functions

What Is a Measurement Function?

Measurement Function

The physical values (such as rms voltage, average current, power, and phase difference) that the WT1800 measures and displays are called measurement functions. Each measurement function is displayed using symbols that correspond to its physical value. For example, “Urms” corresponds to the true rms voltage.

Element

Element refers to a set of input terminals that can receive a single phase of voltage and current to be measured. The WT1800 can contain up to six elements, numbered from 1 to 6. An element number is appended to the measurement function symbol for the measured data that the WT1800 displays, so that you can tell which data belongs to which element. For example, “Urms1” corresponds to the true rms voltage of element 1.

Wiring System

You can specify five wiring systems on the WT1800 to measure the power of various single-phase and three-phase power transmission systems: single-phase, two-wire; single-phase, three-wire; three-phase, three-wire; three-phase, four-wire; and three-phase, three-wire with three-voltage, three-current method.

Wiring Unit

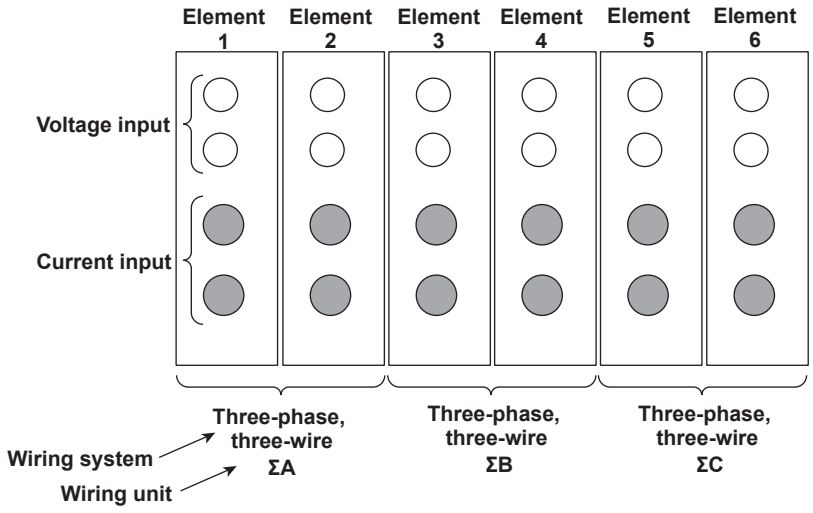
The wiring unit is a set of two or three input elements of the same wiring system that are grouped to measure three-phase power. There can be up to three wiring units: ΣA, ΣB, and ΣC.

▶ Click here.

Σ Functions

The measurement function of a wiring unit is called a Σ function.
For example, “UrmsΣA” corresponds to the average of the voltages of the input elements that are assigned to the wiring unit ΣA. The average value represents the true rms value.

▶ Click here.



Measurement Period

For information about the measurement period for computing measurement functions, see “Measurement Period (SYNC SOURCE).”

▶ Click here.

2 Fundamental Measurement Conditions

Wiring System Settings (WIRING)

The wiring system settings are listed below.

- Wiring system (Wiring)
- Efficiency equation (η Formula)
- Independent input element configuration (Element Independent)
- Delta computation (Δ Measure; option)

Wiring System (Wiring)

There are five wiring systems available on the WT1800. The selectable wiring systems vary depending on the number of installed input elements.

- 1P2W: Single-phase, two-wire system
- 1P3W: Single-phase, three-wire system
- 3P3W: Three-phase, three-wire system
- 3P4W: Three-phase, four-wire system
- 3P3W(3V3A): Three-voltage, three-current method

Wiring Unit

Wiring units are sets of two or three input elements of the same wiring system that are grouped together. You can define up to three wiring units: ΣA, ΣB, and ΣC.

- When there is one wiring unit, that unit is ΣA. You cannot make ΣB or ΣC the first wiring unit.
- When there are two wiring units, those units are ΣA and ΣB. You cannot make ΣC one of the first two wiring units.
- When there are three wiring units, those units are ΣA, ΣB, and ΣC.
- When there are multiple wiring units, element numbers are assigned to them in ascending order. The element numbers are assigned to ΣA, ΣB, and then ΣC.
- Wiring units are composed of input elements that are next to each other. Wiring units cannot consist of input elements that are not next to each other.
- A wiring unit must either be composed of only 50 A input elements or only 5 A input elements. Wiring units cannot consist of different types of input elements.

Σ Functions

The measurement function of a wiring unit is called a Σ function.
For example, “UrmsΣA” corresponds to the average of the voltages of the input elements that are assigned to the wiring unit ΣA. The average value represents the true rms value.

Wiring System Combinations

The following tables provide examples of the wiring system combinations that you can use and the input elements that you can assign to wiring system ΣA, ΣB, or ΣC depending on the number of installed input elements. In addition to the combinations indicated in the tables below, you can also configure any pattern that meets the conditions for wiring units described above.
For details about the relationship between wiring systems and how the values of the measurement functions are determined, see appendix 1 in the getting started guide, IM WT1801-03EN.

Input Element	1
Wiring system combination	1P2W

Input Element	1	2
Wiring system combination	1P2W	1P2W
	1P3W or 3P3W:ΣA	

Input Element	1	2	3
Wiring system combination	1P2W	1P2W	1P2W
	1P3W or 3P3W:ΣA		1P2W
	1P2W	1P3W or 3P3W:ΣA	
	3P4W or 3P3W:ΣA		

Input Element	1	2	3	4
Wiring system combination	1P2W	1P2W	1P2W	1P2W
	1P3W or 3P3W:ΣA		1P3W or 3P3W:ΣB	
	3P4W or 3P3W:ΣA			1P2W
	1P2W	3P4W or 3P3W:ΣA		

Input Element	1	2	3	4	5
Wiring system combination	1P2W	1P2W	1P2W	1P2W	1P2W
	1P3W or 3P3W:ΣA		1P3W or 3P3W:ΣB		1P2W
	1P3W or 3P3W:ΣA		3P4W or 3P3W(3V3A):ΣB		
	3P4W or 3P3W:ΣA			1P3W or 3P3W:ΣB	

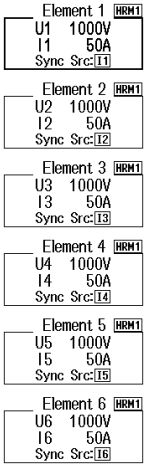
Input Element	1	2	3	4	5	6
Wiring system combination	1P2W	1P2W	1P2W	1P2W	1P2W	1P2W
	1P3W or 3P3W:ΣA		1P3W or 3P3W:ΣB		1P3W or 3P3W:ΣC	
	1P3W or 3P3W:ΣA		3P4W or 3P3W(3V3A):ΣB			1P2W
	3P4W or 3P3W:ΣA			1P3W or 3P3W:ΣB		1P2W
	3P4W or 3P3W:ΣA			3P4W or 3P3W(3V3A):ΣB		

Select the wiring system to match the actual wiring of the circuit under measurement. The method in which the Σ functions (wiring unit measurement functions) are determined varies depending on the wiring system. If the selected wiring system does not match the wiring of the actual circuit, measurements and computation will not be correct.

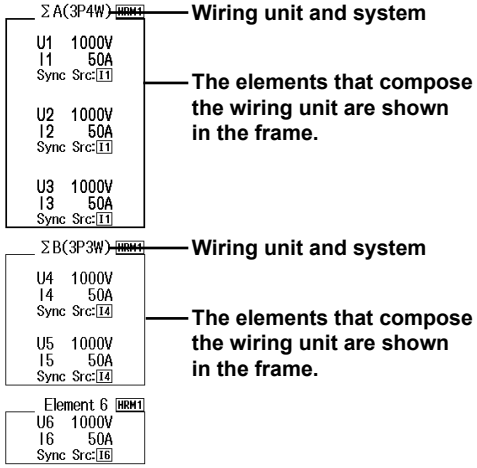
Wiring System Display

The wiring system configuration is displayed on the right side of the screen. Because it is displayed behind the menu, to view it, you need to press the ESC key to hide the menu. The figure below shows wiring system display examples for a model with six input elements installed.

When the wiring systems of elements 1 to 6 are set to single-phase, two-wire



When the wiring system of elements 1, 2, and 3 is set to three-phase, four-wire and the wiring system of elements 4 and 5 is set to three-phase, three-wire



Settings of Elements Grouped in a Wiring Unit

If independent input element configuration is off and a wiring system other than 1P2W is selected when the measurement range, valid measurement range, or valid synchronization source settings of each input element are different, these settings are changed in the manner described below:

- The measurement range is set to the greatest of the measurement ranges of the input elements assigned to the same wiring unit. The external current sensor input range has precedence over the direct input current range.
- The auto range on/off settings are changed to match the setting of the input element whose measurement range is highest. If multiple input elements are set to a common highest measurement range, the setting of the input element with the smallest input element number takes precedence.
- In the valid measurement range settings, all measurement ranges are enabled (selected).
- The synchronization source for a wiring unit is set to the input element whose number is the smallest of the elements in the unit.

At the same time that you press ELEMENT to select the element that you want to set the voltage or current range of, the indicators for the input elements that have been assigned to the same wiring unit illuminate.

Wiring System during High Speed Data Capturing

▶ **Click here.**

Efficiency Equation (η Formula)

You can create an efficiency equation by combining measurement function symbols. The WT1800 can determine the energy conversion efficiency of the device using the numeric values of the measurement functions.

η1 to η4

You can create four efficiency equations (η1 to η4), using the following measurement functions as operands.

- The active powers of each element (P1 to P6)
- The active powers of the Σ functions (PΣA to PΣC)
- The motor output (Pm; on models with the motor evaluation option)
- Udef1 and Udef2

Udef1 and Udef2

To add active powers and motor output and use them in η1 to η4, use Udef1 and Udef2. You can add up to four operands consisting of the measurement functions listed above.

Equation Examples

- **Efficiency of a Single-Phase, Two-Wire Input/Single-Phase, Two-Wire Output Device**
  Input: Power of element 1 (P1)
  Output: Power of element 2 (P2)
  Efficiency equation: P2/P1 × 100 (%)

- **Efficiency of a Single-Phase, Two-Wire Input/Three-Phase, Three-Wire Output Device**
  Input: Power of element 1 (P1)
  Output: Σ power of elements 2 and 3 (PΣA)
  Efficiency equation: PΣA/P1 × 100 (%)

- **Efficiency of a Three-Phase, Three-Wire Input/Three-Phase, Three-Wire Output Device**
  Input: Σ power of elements 1 and 2 (PΣA)
  Output: Σ power of elements 3 and 4 (PΣB)
  Efficiency equation: PΣB/PΣA × 100 (%)

- **Efficiency of a Motor with a Single-Phase, Two-Wire Input**
  Input: Power of element 1 (P1)
  Output: Motor output (Pm)
  Efficiency equation: Pm/P1 × 100 (%)

- **Efficiency of a Motor with a Three-Phase, Three-Wire Input**
  Input: Σ power of elements 1 and 2 (PΣA)
  Output: Motor output (Pm)
  Efficiency equation: Pm/PΣA × 100 (%)

To correctly compute the efficiency, set the power coefficients of all elements so that all power units used in the computation are the same. For example, the efficiency cannot be computed correctly if elements or wiring units used in the computation have different power units, such as W (watt) and J (joule).

Independent Input Element Configuration (Element Independent)

In the wiring system settings, you can select whether to set the measurement range or sync source of input elements in the same wiring unit collectively or independently.

Turning Independent Input Element Configuration On or Off

For example, assume that the wiring system on a model with three input elements is set as follows:
Input elements 1 to 3: Three-phase, four-wire system (3P4W). Input elements 1 to 3 are assigned to a single wiring unit ΣA.

- ON
  The measurement range and sync source can be set independently for each input element included in a wiring unit.
- OFF
  The measurement range and sync source of input elements 1 to 3 are set to the same setting. This is convenient because when you are measuring a three-phase device, you can set the range and sync source settings of all input elements included in a wiring unit simultaneously.

Settings That Are Shared between Input Elements When Independent Input Element Configuration Is Turned Off

- Measurement range (including auto range on or off)
- Direct current input or external current sensor input
- Valid measurement range
- Synchronization source
- Input element group for harmonic measurement (applies to models with the simultaneous dual harmonic measurement option).

Settings That Can Be Configured Independently Even When Independent Input Element Configuration Is Turned Off

- External current sensor conversion ratio (option)
- Scaling values (VT ratio, CT ratio, and power coefficient)
- Input filters (line filter and frequency filter)

These settings can be configured independently for each input element regardless of whether independent input element configuration is turned on or off.

How Settings Are Aligned When You Turn Independent Input Element Configuration from On to Off

When independent input element configuration is switched from on to off, the measurement range, valid measurement range, and sync source settings of each input element in a wiring unit (ΣA, ΣB, or ΣC) are changed as follows:

- The measurement range is set to the greatest of the measurement ranges of the input elements assigned to the same wiring unit. The external current sensor input range has precedence over the direct input current range.
- The auto range on/off settings are changed to match the setting of the input element whose measurement range is highest. If multiple input elements are set to a common highest measurement range, the setting of the input element with the smallest input element number takes precedence.
- In the valid measurement range settings, all measurement ranges are enabled (selected).
- The synchronization source for a wiring unit is set to the input element whose number is the smallest of the elements in the unit.

Delta Computation (Δ Measure; option)

The sum or difference of the instantaneous voltage or current values (sampled data) between the elements in a wiring unit can be used to determine various types of data such as the differential voltage and phase voltage. This operation is called delta computation.

Types of Delta Computation (ΔMeasure Type)

The following types of delta computation are available:

- Differential voltage and differential current (Difference)
- Line voltage and phase current (3P3W > 3V3A)
- Star-delta transformation (Star>Delta)
- Delta-star transformation (Delta>Star)

The delta computation types that you can select vary as indicated below according to the wiring system.

Wiring System	Delta Computation Type
1P3W	Difference, 3P3W>3V3A
3P3W	Difference, 3P3W>3V3A
3P4W	Star>Delta
3P3W(3V3A)	Delta>Star

- **Differential Voltage and Differential Current (Difference)**

  The differential voltage and differential current between two elements can be computed on a single-phase, three-wire system or on a three-phase, three-wire system.

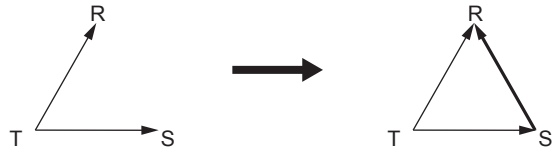
  When you perform delta computation on wiring unit ΣA, the available measurement functions are as follows.
  ΔU1rms[UdiffA], ΔU1mn[UdiffA], ΔU1dc[UdiffA], ΔU1rmn[UdiffA], ΔU1ac[UdiffA]
  ΔIrms[IdiffA], ΔImn[IdiffA], ΔIdc[IdiffA], ΔIrmn[IdiffA], ΔIac[IdiffA]

  * In the measurement functions, *rms*, *mn(mean)*, *dc*, *rmn(r-mean)*, and *ac* are the delta computation modes. *A* indicates the wiring unit.

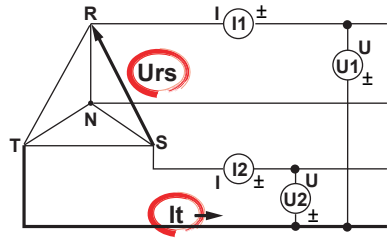
  ▶ **Click here.**

- **Line Voltage and Phase Current (3P3W > 3V3A)**

  You can compute unmeasured line voltages and phase currents by converting the data of a three-phase, three-wire system to the data of the three-voltage, three-current method (3V3A).



  When you perform delta computation on wiring unit ΣA, the available measurement functions are as follows.
  ΔU1rms[UrsA], ΔU1mn[UrsA], ΔU1dc[UrsA], ΔU1rmn[UrsA], ΔU1ac[UrsA]
  ΔIrms[ItA], ΔImn[ItA], ΔIdc[ItA], ΔIrmn[ItA], ΔIac[ItA]

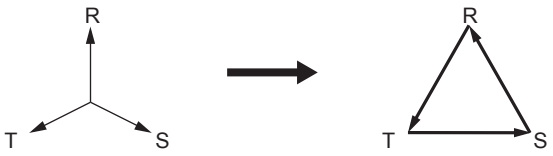


  * In the measurement functions, *rms*, *mn(mean)*, *dc*, *rmn(r-mean)*, and *ac* are the delta computation modes. *A* indicates the wiring unit.

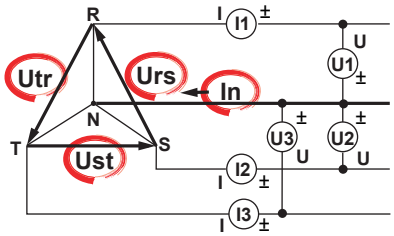
  ▶ **Click here.**

- **Star-delta transformation (Star>Delta)**

  You can use the data from a three-phase, four-wire system to compute the data of a delta connection from the data of a star connection.



  When you perform delta computation on wiring unit ΣA, the available measurement functions are as follows.
  ΔU1rms[UrsA], ΔU1mn[UrsA], ΔU1dc[UrsA], ΔU1rmn[UrsA], ΔU1ac[UrsA]
  ΔU2rms[UstA], ΔU2mn[UstA], ΔU2dc[UstA], ΔU2rmn[UstA], ΔU2ac[UstA]
  ΔU3rms[UtrA], ΔU3mn[UtrA], ΔU3dc[UtrA], ΔU3rmn[UtrA], ΔU3ac[UtrA]
  ΔUΣrms[UΣA], ΔUΣmn[UΣA], ΔUΣdc[UΣA], ΔUΣrmn[UΣA], ΔUΣac[UΣA]
  ΔIrms[InA], ΔImn[InA], ΔIdc[InA], ΔIrmn[InA], ΔIac[InA]

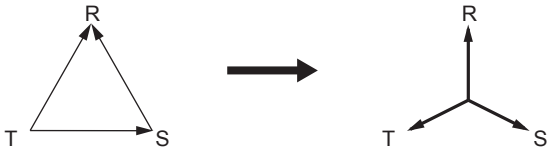


  * In the measurement functions, *rms*, *mn(mean)*, *dc*, *rmn(r-mean)*, and *ac* are the delta computation modes. *A* indicates the wiring unit.

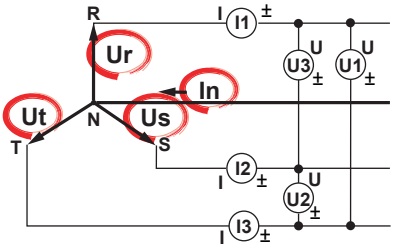
  ▶ **Click here.**

- **Delta-star transformation (Delta>Star)**

  Using the data from a three-phase, three-wire system that uses a three-voltage, three-current method, you can compute the data of a star connection from the data of a delta connection. This function is useful when you wish to observe the phase voltage of an object that has no neutral line, such as a motor. The center N of the star connection is computed as the center of the delta connection. If the actual center of the star connection does not match the center of the delta connection, an error results.



  When you perform delta computation on wiring unit ΣA, the available measurement functions are as follows.
  ΔU1rms[UrA], ΔU1mn[UrA], ΔU1dc[UrA], ΔU1rmn[UrA], ΔU1ac[UrA]
  ΔU2rms[UsA], ΔU2mn[UsA], ΔU2dc[UsA], ΔU2rmn[UsA], ΔU2ac[UsA]
  ΔU3rms[UtA], ΔU3mn[UtA], ΔU3dc[UtA], ΔU3rmn[UtA], ΔU3ac[UtA]
  ΔUΣrms[UΣA], ΔUΣmn[UΣA], ΔUΣdc[UΣA], ΔUΣrmn[UΣA], ΔUΣac[UΣA]
  ΔIrms[InA], ΔImn[InA], ΔIdc[InA], ΔIrmn[InA], ΔIac[InA]
  ΔP1[PrA]
  ΔP2[PsA]
  ΔP3[PtA]
  ΔPΣ[PΣA]



* In the measurement functions, *rms*, *mn(mean)*, *dc*, *rmn(r-mean)*, and *ac* are the delta computation modes. *A* indicates the wiring unit.

▶ **Click here.**

For information about equations, see appendix 1 in the getting started guide, IM WT1801-03EN.
For information about the measurement period, see “Measurement Period.”

▶ **Click here.**

Delta Computation Modes (ΔMeasure Mode)

You can select the voltage or current mode to be displayed as delta computation values from the following: rms, mean, dc, r−mean, ac

- We recommend that you set the measurement range and scaling (VT/CT ratio and coefficients) of the elements that are undergoing delta computation as closely as possible. Using different measurement ranges or scaling causes the measurement resolutions of the sampled data to be different. This results in errors.
- The numbers (1, 2, and 3) that are attached to delta computation measurement function symbols have no relation to the element numbers. The computation of all delta measurement functions, from ΔU1 to ΔPΣ, varies depending on the wiring system and the delta computation type. For details, see appendix 1 in the getting started guide, IM WT1801-03EN.
- When only one element is installed in the WT1800, this feature cannot be used, and its settings do not appear.
- Delta computation cannot be performed on a single-phase, two-wire (1P2W) wiring system.

Selecting an Element Whose Measurement Range You Want to Specify (ELEMENT)

Select an element whose measurement range you want to specify. Press ELEMENT to switch in order between the indicators of the installed elements. When independent input element configuration is off, the selected elements will switch by wiring unit, according to the wiring system.

Selecting All Input Elements (ALL)

At the same time, you can select the currently selected element and all elements that meet the following conditions. You can set their voltage and current ranges at the same time.

Conditions for Simultaneous Element Selection

- Only input elements of the same type (50 A input or 5 A input) can be selected.
- Only input elements whose valid measurement range settings are the same can be selected.

Initial Values for Simultaneously Selected Elements

The voltage range, current range, and auto range on/off settings of the element that was selected before you selected the other elements are copied to all the other selected elements.

After you have selected all the input elements, changes that you make to the voltage range, current range, and auto range on/off settings affect all the selected input elements.

To disable simultaneous selection and specify independent input element settings, press ELEMENT.

Voltage Range (RANGE UP/DOWN (V))

The voltage range can be fixed (when auto range is set to off) or determined automatically (when auto range is set to on).

Fixed Ranges

When the voltage range is fixed, you can select a range from the available options. The selected voltage range does not change even if the amplitude of the input signal changes. Set the range in reference to the rms value of the input signal.

When the Crest Factor Is Set to CF3

You can select from 1.5 V, 3 V, 6 V, 10 V, 15 V, 30 V, 60 V, 100 V, 150 V, 300 V, 600 V, and 1000 V.

When the Crest Factor Is Set to CF6

You can select from 0.75 V, 1.5 V, 3 V, 5 V, 7.5 V, 15 V, 30 V, 50 V, 75 V, 150 V, 300 V, and 500 V.

Auto Range

▶ Click here.

- Set the range in reference to the rms value of the input signal. For example, if you are applying a 100-Vrms sinusoidal signal, set the range to 100 V.
- When measuring a signal other than a sine wave (such as a distorted wave), you can obtain accurate measurements by selecting the smallest measurement range that does not produce any of the conditions below.
  - The input peak over-range indicator at the top center of the screen illuminates or blinks in red.
  - The measured values of the voltage and current are indicated as being overload values (“-OL-”).
- The peak over-range indicator may not illuminate or blink in the following cases.
  - If the pulse width is narrow, and the peak value of the waveform cannot be acquired at the sampling rate of the WT1800 (approximately 2 Ms/S).
  - If the high frequency components of the pulse waveform attenuate due to the bandwidth limitations of the WT1800 measurement circuit, causing the waveform peak value to be less than the peak over-range detection level.
- When a signal with the peak which becomes more than about 10 times of the range is input, it takes about 1 second to change the range.
- When the secondary output of a VT (voltage transformer) is being applied to the voltage input terminal, set the voltage range according to the maximum value of the VT output. Then, use the scaling feature to set the VT ratio.

- To display a list of the range settings of all input elements, see “Displaying the Setup Parameter List.” You can change measurement ranges from the list.
  ▶ Click here.

Auto Voltage Range (AUTO (V))

When you press AUTO, the AUTO key illuminates, and the range is set automatically. The measurement range is switched automatically depending on the amplitude of the input signal as described below. The different ranges used in the auto range are the same as those available for the fixed range.

Range Increase

The measurement range is increased when any of the following conditions is met.

- The data of measurement function Urms or Irms exceeds 110% of the measurement range.
- The crest factor is set to CF3 and the data of Upk* or Ipk* exceeds 330% of the current measurement range.
- The crest factor is set to CF6 and the data of Upk* or Ipk* exceeds 660% of the current measurement range.
- If all the installed input elements are selected (all the element indicators are illuminated), the measurement range is increased on all input elements when any of the elements meets the range-increase conditions described above.
- When a wiring unit is configured, the measurement range is increased on all input elements in the wiring unit when any of the elements in the unit meets the range-increase conditions described above.

Range Decrease

The measurement range is decreased when all the following conditions are met.

- The data of Urms or Irms is less than or equal to 30% of the measurement range.
- The data of Urms or Irms is less than or equal to 105% of the next lower range.
- The crest factor is set to CF3 and the data of Upk* or Ipk* is less than or equal to 300% of the next lower range.
- The crest factor is set to CF6 and the data of Upk* or Ipk* is less than or equal to 600% of the next lower range.

* Even if the NULL feature is on, the values are determined as if it were off.

- If all the installed input elements are selected (all the element indicators are illuminated) and meet the range-decrease conditions described above, all their measurement ranges are decreased.
- When a wiring unit is configured and all the elements in the unit meet the range-increase conditions described above, all their measurement ranges are increased.

- If you disable a measurement range in the valid measurement range settings, that measurement range is skipped, and the auto range feature operates using only the valid measurement ranges.
- When non-periodic pulse waveforms are applied, the range may not remain constant. If this happens, use the fixed range setting.

Current Range (RANGE UP/DOWN (A))

The current range can be fixed (when auto range is set to off) or determined automatically (when auto range is set to on).

Fixed Ranges

When the current range is fixed, you can select a range from the available options. The selected current range does not change even if the amplitude of the input signal changes. Set the range in reference to the rms value of the input signal.

For 5 A Input Elements

- **When the Crest Factor Is Set to CF3**
  You can select from 10 mA, 20 mA, 50 mA, 100 mA, 200 mA, 500 mA, 1 A, 2 A, and 5 A.
- **When the Crest Factor Is Set to CF6**
  You can select from 5 mA, 10 mA, 25 mA, 50 mA, 100 mA, 250 mA, 500 mA, 1 A, and 2.5 A.

For 50 A Input Elements

- **When the Crest Factor Is Set to CF3**
  You can select from 1 A, 2 A, 5 A, 10 A, 20 A, and 50 A.
- **When the Crest Factor Is Set to CF6**
  You can select from 500 mA, 1 A, 2.5 A, 5 A, 10 A, and 25 A.

Auto Range

This is the same as the auto range feature for voltage.

▶ **Click here.**

- When the secondary output of a CT (current transformer) or a clamp-type current sensor that outputs current is being applied to the current input terminal, set the current range according to the maximum value of the CT or current sensor output. Then, use the scaling feature to set the CT ratio or the conversion ratio of the clamp-type current sensor that outputs current.

Auto Current Range (AUTO (A))

This is the same as the auto range feature for voltage.

▶ **Click here.**

Power Range

The measurement ranges (power ranges) of active power (P), apparent power (S), and reactive power (Q) are as follows:

Wiring System	Power Range
1P2W (single-phase, two-wire system)	Current range × voltage range
1P3W (single-phase, three-wire system) 3P3W (three-phase, three-wire system) 3P3W (3V3A; three-voltage, three-current method)	Voltage range × current range × 2 (when the voltage and current ranges on the elements in the wiring unit are set to the same range)
3P4W (three-phase, four-wire system)	Voltage range × current range × 3 (when the voltage and current ranges on the elements in the wiring unit are set to the same range)

- When the result of the equation voltage range × current range exceeds 1000 W (VA or var), the displayed unit changes to kW (kVA or kvar).
- Number of displayed digits (display resolution)
  ▶ Click here.

For a detailed list of the available voltage and current range combinations and power ranges when all the elements have the same voltage or current range, see appendix 4 in the getting started guide, IM WT1801-03EN.

In auto range mode, because the voltage and current ranges switch independently according to range increase and decrease conditions, different power ranges may be set for the same power value.

External Current Sensor Range (EXT SENSOR; option)

The output of current sensors that produce voltage, such as shunts and clamps, can be applied to an element's external current sensor input connector (EXT) and measured. Press EXT SENSOR so that it illuminates, and then set the external current sensor range.
The external current sensor range can be fixed (when auto range is set to off) or determined automatically (when auto range is set to on).

Fixed Ranges

When the current range is fixed, you can select a range from the available options. The selected current range does not change even if the amplitude of the input signal changes. Set the range in reference to the rms value of the input signal.

- **When the Crest Factor Is Set to CF3**
  You can select from 50 mV, 100 mV, 200 mV, 500 mV, 1 V, 2 V, 5 V, and 10 V.
- **When the Crest Factor Is Set to CF6**
  You can select from 25 mV, 50 mV, 100 mV, 250 mV, 500 mV, 1 V, 2.5 V, and 5 V.

Auto Range

This is the same as the auto range feature for voltage.
▶ Click here.

External Current Sensor Conversion Ratio (SENSOR RATIO; option)

Set the conversion ratio used to measure the signal received by the external current sensor input connector (EXT) from a current sensor that produces voltage. Set how many millivolts the current sensor transmits when 1 A of current is applied (conversion ratio). Then, the input signal can be made to correspond to the numeric data or waveform display data that is obtained when the current is directly applied to the input terminals. When using a current sensor that produces current, set the conversion ratio as the CT ratio.

▶ Click here.

Measurement Function	Conversion Ratio	Data before Transformation	Transformation Result
Current I	E	I_S (current sensor output)	I_S/E
Active power P	E	P_S	P_S/E
Apparent power S	E	S_S	S_S/E
Reactive power Q	E	Q_S	Q_S/E
Max./min. current Ipk	E	Ipk_S (current sensor output)	Ipk_S/E

Element1 to Element6

Use the soft keys to select an element, and then set the element's external current sensor conversion ratio to a value within the following range.
0.0001 to 99999.9999

Copying the External Current Sensor Conversion Ratio (Exec Copy Σ)

Copy the external current sensor conversion ratio of the selected input element to the other input elements in the same wiring unit.

External Current Sensor Range and Conversion Ratio Configuration Example

When you measure a current with a maximum value of 100 A using a current sensor that produces 10 mV when 1 A of current is flowing, the maximum voltage that the current sensor produces is 10 mV/A × 100 A = 1 V. Therefore, configure the settings as indicated below.

- External current sensor range: 1 V
- External current sensor conversion ratio: 10 mV/A

- When you want to divide the external current sensor output by the conversion ratio and read the current of the circuit under measurement directly, turn the external VT/CT scaling feature off. If the feature is turned on, the value will be further multiplied by the CT ratio.
- When you are measuring a signal other than a sine wave (such as a distorted wave), you can obtain accurate measurements by selecting the smallest measurement range that does not produce any of the conditions below.
  - The input peak over-range indicator at the top center of the screen illuminates or blinks in red.
  - The measured values of the voltage and current are indicated as being overload values ("-OL-").

External Current Sensor Range Display Format (DIRECT/ MEASURE; option)

You can select the external current sensor range display format from the following options.

- DIRECT (direct input value display)
  Values are displayed within the external current sensor range (voltage). This setting is useful when you want to set the external current sensor range using the voltage received by the WT1800 from the external current sensor as a guide.
- MEASURE (measurement range display)
  The external current sensor range is divided by the external current sensor conversion ratio, and the resulting (current) range is displayed. This setting is useful when you want to set the external current sensor range using the current measured by the external current sensor as a guide. For example, if you are using a current sensor that produces 10 mV when it receives 1 A (external current sensor conversion ratio: 10 mV/A) and you set the external current sensor range to 1 V, the displayed current range is 100 A.

Scaling (SCALING)

You can set coefficients for when you apply a voltage or current signal from an external VT (voltage transformer) or CT (current transformer).

Turning Scaling On and Off (Scaling)

You can select whether to apply the VT ratio, CT ratio, and power coefficient to applicable measurement functions.
When reading measured values directly by using a VT or CT (or current sensor), select ON. When you select ON, the SCALING key and the Scaling indicator at the top of the screen illuminate.

Applicable Measurement Functions

Voltage (U), current (I), power (P, S, and Q), maximum and minimum voltages (U+pk and U-pk), and maximum and minimum currents (I+pk and I-pk)

- ON: The measurement functions above are multiplied by the VT ratio, CT ratio, or power coefficient.
- OFF: The measurement functions above are not multiplied by the VT ratio, CT ratio, or power coefficient. The output values of the VT and CT are displayed directly as numeric data.

VT Ratio (VT Scaling)

Set the VT ratio when applying the secondary output of a VT to the voltage input terminal. Then, set the voltage range according to the maximum VT output.

Element1 to Element6

Use the soft keys to select an element, and then set the element's VT ratio to a value within the following range.
0.0001 to 99999.9999

Copying the VT Ratio (Exec Copy Σ)

Copy the VT ratio of the selected input element to the other input elements in the same wiring unit.

CT Ratio (CT Scaling)

Set the CT ratio (or the conversion ratio of the current sensor that produces current) when applying the secondary output of a CT or clamp-type current sensor that produces current to the current input terminal. Then, set the current range according to the maximum CT or current sensor output.

Element1 to Element6

Use the soft keys to select an element, and then set the element's CT ratio to a value within the following range.
0.0001 to 99999.9999

Copying the CT Ratio (Exec Copy Σ)

Copy the CT ratio of the selected input element to the other input elements in the same wiring unit.

Power Coefficient (SF Scaling; scaling factor)

By setting the power coefficient (SF), you can display the measured active power, apparent power, and reactive power after they have been multiplied by a coefficient.

Measurement Function	Data before Transformation	Transformation Result	
Voltage U	U_2 (secondary output of the VT)	$U_2 \times V$	V: VT ratio
Current I	I_2 (secondary output of the CT)	$I_2 \times C$	C: CT ratio
Active power P	P_2	$P_2 \times V \times C \times SF$	SF: Power coefficient
Apparent power S	S_2	$S_2 \times V \times C \times SF$	
Reactive power Q	Q_2	$Q_2 \times V \times C \times SF$	
Max./min. voltage Upk	Upk_2 (secondary output of the VT)	$Upk_2 \times V$	
Max./min. current Ipk	Ipk_2 (secondary output of the CT)	$Ipk_2 \times C$	

Element1 to Element6

Use the soft keys to select an element, and then set the element's power coefficient to a value within the following range.
0.0001 to 99999.9999

Copying the Power Coefficient (Exec Copy Σ)

Copy the power coefficient of the selected input element to the other input elements in the same wiring unit.

- If the value of the result of multiplying the measured value by the VT ratio, CT ratio, or power coefficient (scaling factor) exceeds 9999.99 M, "-OF-" will appear in the numeric data display frame.
- You can view the VT and CT ratios and the power coefficients of all input elements by displaying the setup parameter list.
  ▶ **Click here.**
- To correctly compute the power and efficiency of Σ functions, set the power coefficients of all elements so that all power units used in the computation are the same. For example, the efficiency cannot be computed correctly if elements or wiring units used in the computation have different power units, such as W (watt) and J (joule). To compute the efficiency correctly, make all the power units the same (either all W or all J).

Valid Measurement Range (CONFIG(V)/CONFIG(A))

You can enable or disable a measurement range by selecting or clearing its check box. The WT1800 switches between enabled measurement ranges. Disabled measurement ranges are skipped. For example, when using auto range to measure the current of a device that produces 2 A when operating and 100 mA when in standby, disable the 200 mA, 500 mA, and 1 A ranges. When the device is in standby, the range will be 200 mA. When the device begins operating, the WT1800 will skip the intermediate 200 mA, 500 mA, and 1 A ranges and switch directly to the 2 A range.

Element1 to Element6

For each input element or wiring unit, you can enable all measurement ranges at the same time (All ON).

Measurement Range Box (Left column of the list)

You can enable (All ON) or disable (All OFF) a range for all input elements at the same time.

Measurement Range in Which a Peak Over-Range Has Occurred (Peak Over Jump)

You can specify which measurement range to switch to when the auto range feature is enabled and a peak over-range occurs. The background of the selected measurement range turns yellow. If a peak over-range occurs when this feature is disabled, the WT1800 increases the measurement range, switching between valid measurement ranges (measurement ranges whose check boxes have been selected).

You can specify valid current measurement ranges for each input element type.

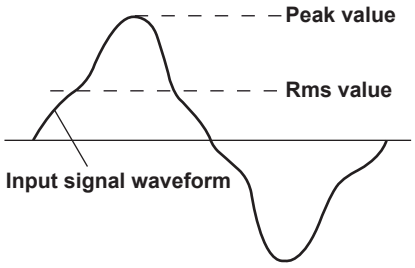
- **50A Input Element**
  Select the valid direct input measurement ranges of 50 A input elements.
- **5A Input Element**
  Select the valid direct input measurement ranges of 5 A input elements.
- **Ext Sensor Input Element (Option)**
  Select the valid external current sensor input measurement range.

- You cannot set all measurement ranges to OFF. There must be at least one valid range.
- The settings for the valid range and for the measurement range to switch to when peak over-range occurs are shared by all the input elements in a wiring unit.
- When independent input element configuration is disabled and you change the wiring system, all measurement ranges are enabled (set to their initial setting).
- When you switch independent input element configuration from on to off, all measurement ranges are enabled (set to their initial setting).
- If you set the valid range setting for the current measurement range to OFF, the WT1800 switches to the next highest measurement range. If there is no measurement range above the current one, the WT1800 switches to the next lowest measurement range.

Crest Factor (Crest Factor)

The crest factor is defined as the ratio of the peak value of the waveform to the rms value.

$$\text{Crest factor (CF)} = \frac{\text{Peak value}}{\text{Rms value}}$$



On the WT1800, the crest factor is the ratio of the maximum applicable peak value to the measurement range.

$$\text{Crest factor (CF)} = \frac{\text{Peak value that can be input}}{\text{Measurement range}}$$

You can set the crest factor to CF3 or CF6.

- CF3: The crest factor is 3.
- CF6: The crest factor is 6.

The measurable crest factor is as follows:

$$\text{Crest factor (CF)} = \frac{\{\text{measurement range} \times \text{CF setting (3 or 6)}\}}{\text{Measured value (rms value)}}$$

* However, the peak value of the input signal must be less than or equal to the maximum allowable input.

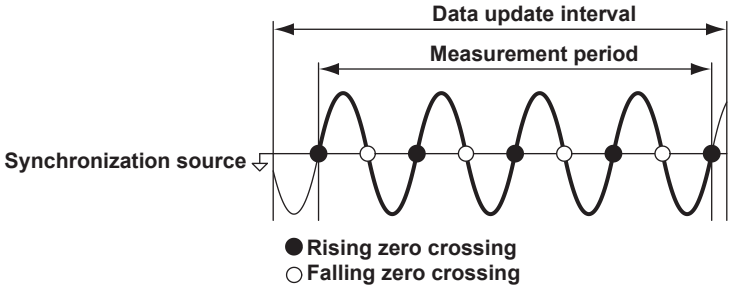
If the crest factor of the measured signal is greater than the specifications of the WT1800 (the crest factor defined at the rated input), you can measure the signal by setting a greater measurement range. For example, even if CF is set to 3, measurement is possible for signals with a crest factor greater than or equal to 5 when the measured value (rms value) is less than 60% of the measurement range. If the minimum effective input (1% of the measurement range) is being applied when CF is set to 3, measurement for CF = 300 is possible.
The voltage range, current range, effective input range, and measurement accuracy vary depending on the crest factor setting. For details, see chapter 6 in the getting started guide, IM WT1801-03EN.

- When you change the crest factor, the following settings change for all elements.
  - All elements are automatically set to their maximum voltage and current ranges.
  - In the valid measurement range settings, all measurement ranges are enabled (selected).
- If the crest factor is set to CF6, the measurement conditions of crest factor 5 and higher required by IEC62018 are met.
- When measuring waveforms whose crest factor is less than or equal to CF3, you can achieve more accurate measurements by setting the crest factor to 3.

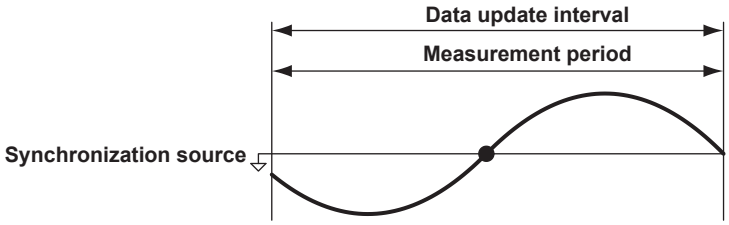
Measurement Period (SYNC SOURCE)

Measurement Period for Measurement Functions Used in Normal Measurement

The measurement period is determined by the input signal that is used as the reference (synchronization source). The measurement period is set within the data update interval between the first point where the sync source crosses the level-zero point (center of the amplitude) on a rising slope (or falling slope) and the last point where the sync source crosses the level-zero point (center of the amplitude) on a rising slope (or falling slope).



If there is not more than one rising or falling slope within the data update interval, the entire data update interval is set as the measurement period.



The measurement period for determining the numeric data of the peak voltage or peak current is always the entire span of the data update interval. Therefore, the measurement period for the measurement functions that are determined on the basis of the maximum voltage or current value (U+pk, U-pk, I+pk, I-pk, CfU, and CfI) is also the entire span of the data update interval.
For details, see appendix 5 in the getting started guide, IM WT1801-03EN.

Measurement Period for Measurement Functions Used in Harmonic Measurement

The measurement period extends from the first sample in the data update interval for the number of points indicated below:

- When the data update interval is 50 ms, 100 ms, or 200 ms: 1024 points
- When the data update interval is 500 ms, 1 s, 2 s, 5 s, 10 s, or 20 s: 8192 points

The WT1800 determines the harmonic sampling frequency automatically based on the period of the signal that is set as the PLL source. The sampling data and measurement period that are used to determine the values of harmonic measurement functions may be different from those used to determine the values of normal measurement functions.

Element1 to Element6

Use the soft keys to select an element, and then select the signal to use as the sync source from the options listed below. The available options vary depending on the installed elements. When independent input element configuration is off, elements in the same wiring unit have the same sync source.
U1, I1, U2, I2, U3, I3, U4, I4, U5, I5, U6, I6, Ext Clk (external clock),* and None

* When you select Ext Clk, the external signal applied to the external clock input connector (EXT CLK) on the rear panel is used as the sync source. For the EXT CLK connector specifications, see section 4.3 in the getting started guide, IM WT1801-03EN.

- If you specify no sync source by selecting “None,” all of the sampled data within the data update interval is used to determine the numeric data. When you are measuring DC signals, this method can be used to prevent noise from causing errors in the detection of the measurement period.
- If the sync source is not set correctly, the measured value may fluctuate or be incorrect. When you set the sync source, refer to appendix 5 in the getting started guide, IM WT1801-03EN.

Line Filter (LINE FILTER)

There are two types of input filters, line filters and frequency filters.
Because the line filter is inserted into the voltage and current measurement input circuits, it directly affects voltage, current, and power measurements (see the block diagram in appendix 11 in the getting started guide, IM WT1801-03EN). When the line filter is turned on, measured values do not contain high frequency components. Thus, the voltage, current, and power of inverter waveforms, strain waveforms, etc., can be measured with their high frequency components eliminated.

Element1 to Element6

Use the soft keys to select an element, and then turn the line filter on or off, and set the cutoff frequency.
You can set the cutoff frequency to
300 kHz, 1 MHz, or a value from 0.1 kHz to 100.0 kHz (in 0.1 kHz steps)

- If the line filter of even one of the elements is not set to OFF, the LINE FILTER key and the Line Filter indicator at the top of the screen illuminate.
- Selecting OFF disables the line filter.

Copying the Line Filter Setting (Exec Copy Σ)

Copy the line filter on/off setting and cutoff frequency of the selected input element to the other input elements in the same wiring unit.

Line Filter for High Speed Data Capturing

▶ **Click here.**

Frequency Filter (FREQ FILTER)

The frequency filter is inserted into the frequency measurement input circuit and affects frequency measurements. It also affects the detection of the measurement period for voltage, current, and power measurements (see appendix 5 in the getting started guide, IM WT1801-03EN). In this case, the filter also acts as a filter for detecting the zero-crossing of the synchronization source signal more accurately. The frequency filter is not inserted into the voltage and current measurement input circuits. Therefore, the measured values include high frequency components even when the frequency filter is turned on.

Element1 to Element6

Use the soft keys to select an element, and then select the element’s cutoff frequency from the options listed below.
OFF, 100 Hz, and 1 kHz

- The WT1800 detects the zero-crossing point with a hysteresis of approximately 5% of the measurement range.
- If even one element is not set to OFF, the Freq Filter indicator at the top of the screen illuminates.
- If the line filter described above is on, it affects the frequency measurement even when the frequency filter is off.
- We recommend that you turn the frequency filter on when the input signal frequency is less than or equal to 440 Hz.

Data Update Interval (UPDATE RATE)

The data update interval is the interval at which the data that is used in measurement functions is sampled.
You can select the data update interval from the options below.
50 ms, 100 ms, 200 ms, 500 ms, 1 s, 2 s, 5 s, 10 s, and 20 s
At each data update interval, the numeric data is updated, stored, transmitted through a communication interface, and converted and output as analog signals.
To capture relatively fast load fluctuations in the power system, select a fast data update rate. To capture low frequency signals, select a slow data update rate.

Fast

The WT1800 switches to the next fastest data update interval (out of the intervals listed above).

Slow

The WT1800 switches to the next slowest data update interval (out of the intervals listed above).

Current Rate

Displays the current data update interval. You can press a soft key to select a data update interval from the options listed above.

- The display update intervals of numeric data and waveform data may be longer than the data update interval.
- The lowest measurable AC signal frequency varies depending on the data update interval. The measured value may not be stable if an AC signal of a frequency lower than the low frequency measurement limit (see section 6.5 in the getting started guide, IM WT1801-03EN) is measured.

Averaging (AVG)

You can take exponential or moving averages of the numeric data. The averaging function is effective when reading of the numeric display is difficult due to fluctuations. This occurs when the fluctuation of the power supply or the load is large or when the input signal frequency is low.

Turning Averaging On and Off (Averaging)

Measurement Functions Used in Normal Measurement

You can select whether to average values. When you enable averaging (ON), the AVG key and the AVG indicator at the top of the screen illuminate.

Measurement Functions Used in Harmonic Measurement (Option)

- If averaging is turned on, and the averaging type is Exp (exponential averaging), averaging is performed on harmonic measurement functions.
- Even if averaging is turned on, if the averaging type is Lin (moving average), averaging is not performed on harmonic measurement functions.

Averaging Types (Type)

You can use exponential or moving averages.

Exponential Averaging (Exp)

With the specified attenuation constant, the numeric data is exponentially averaged according to the equation below.

$$D_n = D_{n-1} + \frac{(M_n - D_{n-1})}{K}$$

D_n: Displayed value that has been exponentially averaged n times. (The first displayed value, D_1, is equal to M_1.)
D_{n-1}: Displayed value that has been exponentially averaged n – 1 times.
M_n: Measured data at the n^{th} time.
K: Attenuation constant (select from 2 to 64)

Moving Average (Lin)

The specified average count is used to compute moving averages according to the equation below.

$$D_n = \frac{M_{n-(m-1)} + \cdots M_{n-2} + M_{n-1} + M_n}{m}$$

D_n: n–(m–1)th to the n^{th} time
$M_{n-(m-1)}$: Measured data at the n–(m–1)th time
……
……
M_{n-2}: Measured data at the n – 2th time.
M_{n-1}: Measured data at the n – 1st time.
M_n: Measured data at the n^{th} time.
m: Average count (select a number from 8 to 64)

Attenuation Constant or Average Count (Count)

- If the averaging type is Exp (exponential averaging), set the attenuation constant to a value within the following range.
  2 to 64
- If the averaging type is Lin (moving average), set the average count to a value within the following range.
  8 to 64

Measurement Functions That Are Averaged

The measurement functions that are directly averaged are indicated below. Other functions that use these functions in their computation are also affected by averaging. For details about how the values of the measurement functions are determined, see appendix 1 in the getting started guide, IM WT1801-03EN.

Measurement Functions Used in Normal Measurement

- Urms, Umn, Udc, Urmn, Uac, Irms, Imn, Idc, Irmn, Iac, P, S, and Q
- ΔU1 to ΔPΣ (on models with the delta computation option)
- Torque, speed, and Pm (on models with the motor evaluation option)
- Aux1 and Aux2 (on models with the auxiliary input option)
- λ, Φ, CfU, CfI, Pc, q, q+, q–, and η1 to η4 are computed using the averaged values of Urms, Irms, P, S, and Q.
- Slip is computed using the averaged value of Speed (on models with the motor evaluation option).

Measurement Functions Used in Harmonic Measurement (Option)

- U(k), I(k), P(k), S(k), and Q(k)
- λ(k), and Φ(k) are computed using the averaged values of P(k) and Q(k).
- Z, Rs, Xs, Rp, Xp, Uhdf, Ihdf, Phdf, Uthd, Ithd, Pthd, Uthf, Ithf, Utif, Itif, hvf, hcf, and K–factor are computed using the averaged values of U(k), I(k), and P(k).
  k: The harmonic order

Measurement Functions That Do Not Perform Averaging

The following measurement functions do not perform averaging.

Measurement Functions Used in Normal Measurement

fU, fI, U+pk, U–pk, I+pk, I–pk, P+pk, P−pk, Time, WP, WP+, WP–, WPΣ, WP+Σ, WP–Σ, WS, WQ, and SyncSp (on models with the motor evaluation option)

Measurement Functions Used in Harmonic Measurement (Option)

ΦU(k), ΦI(k), ΦUi–Uj, ΦUi–Uk, ΦUi–Ii, ΦUj–Ij, ΦUk–Ik, fPLL1, fPLL2, EaU, and EaI

* k: The harmonic order

Measurement Functions Used in Normal and Harmonic Measurement (Option)

F1 to F20 and Event 1 to Event 8

- When averaging is turned on, the average value of multiple measurements is determined and displayed. If the input signal changes drastically, it will take longer for the change to be reflected in the measured values when averaging is used.
- A larger attenuation constant (for exponential averaging) or average count (for moving averages) will result in more stable (and less responsive) measured values.

Displaying the Setup Parameter List (INPUT INFO)

The setup parameter list appears in the top half of the screen.

Display Format (FORM)

Input Element Settings List (Power Element Settings)

The wiring system, measurement range, scaling factor, synchronization source, line filter, and frequency filter settings for each element are displayed.

Measurement Range Settings List (Range Settings)

The measurement range settings for each element are displayed. Measurement ranges that have been disabled in the valid measurement range settings are dimmed.

Display Items (ITEM)

Turning the Display Frame On and Off (Display Frame)

▶ Click here.

- The setup parameter list shows the settings when measurement took place. If the measurement range or some other setting is changed while the hold feature is on, the changes will not be reflected in the list.
- When the setup parameter list is displayed, press FORM to switch between the FORM menu for the setup parameter list and the FORM menu for the display in the bottom half of the screen. Likewise, press ITEM to switch between ITEM menus.

3 Harmonic Measurement Conditions (Option)

Harmonic Measurement Conditions (HRM SET)

Using harmonic measurement, you can measure functions that are based on the voltage, current, and power harmonics and their distortion factors; on the phase angle of each harmonic relative to the fundamental; etc. You can also compute the harmonic distortion factors for voltage and current.
For a list of the measurement functions that can be measured with harmonic measurement and their descriptions, see “Harmonic Measurement Functions” under “Items That This Instrument Can Measure.”

▶ **Click here.**

Models with the Harmonic Measurement Option

The following menu items appear.

- PLL source (PLL Source)
- Measured harmonic orders (Min Order/Max Order)
- Distortion Factor Equation (Thd Formula)

Models with the Simultaneous Dual Harmonic Measurement Option

The following menu items appear.

- Input element group (Element Settings)
- PLL source of group Hrm1 (Hrm1 PLL Source)
- Measured harmonic orders of group Hrm1 (Min Order/Max Order)
- Distortion factor equation of group Hrm1 (Thd Formula)
- PLL source of group Hrm2 (Hrm2 PLL Source)
- Measured harmonic orders of group Hrm2 (Min Order/Max Order)
- Distortion factor equation of group Hrm2 (Thd Formula)

PLL Source (PLL Source)

For harmonics to be measured, the fundamental period (the period of the fundamental signal) that will be used to analyze the harmonics must be determined. The signal for determining the fundamental period is the PLL (phase locked loop) source.

Select the PLL source from the choices below. The available options vary depending on the installed elements.
U1, I1, U2, I2, U3, I3, U4, I4, U5, I5, U6, I6, and Ext Clk*

* If you select Ext Clk, the frequency of the signal applied to the rear panel’s external clock input connector (EXT CLK) is used as the fundamental frequency for harmonic measurement. For the EXT CLK connector specifications, see section 4.3 in the getting started guide, IM WT1801-03EN.

- Select a signal that has the same period as the signal that you want to measure the harmonics of. For stable harmonic measurement, choose an input signal for the PLL source that has as little distortion and fluctuation as possible. If the fundamental frequency of the PLL source fluctuates or if the fundamental frequency cannot be measured due to waveform distortion, correct measurements will not be obtained. When the measured item is a switching power supply and in other cases where the distortion of the voltage signal is smaller than that of the current signal, we recommend that the PLL source be set to the voltage.
- If all of the input signals are distorted or the amplitude is small compared to the measurement range, the specifications may not be met. To achieve stable, accurate measurements on high harmonics, set the PLL source to an external clock signal and apply a signal with the same period as the input signal to the external clock input connector.
- If the fundamental frequency is less than or equal to 440 Hz and the signal contains high frequency components, we recommend that you turn the frequency filter on. This filter is only effective on the frequency measurement circuit.
- If the amplitude level of the signal applied to the element that is specified as the PLL source is small compared to the range, PLL synchronization may not be achieved. If the crest factor is set to CF3, set the measurement range so that the amplitude level of the PLL source is at least 50%. If the crest factor is set to CF6, set the measurement range so that the amplitude level of the PLL source is at least 100%.
- If the frequency of the PLL source changes, correct measured values are displayed four data updates after the change. Correct measured values may not be obtained immediately after the PLL source or its frequency changes, because the PLL circuit inside the WT1800 redetects the frequency.

Measured Harmonic Orders (Min Order/Max Order)

The harmonic measurement range can be specified. The harmonic orders specified here are used to determine the numeric data of the distortion factor.

▶ Click here.

Minimum Harmonic Order to Be Measured (Min Order)

Select from the following.

- 0: The 0th order (DC) component is included when numeric harmonic waveform data is determined.
- 1: The 0th order (DC) component is not included when numeric harmonic waveform data is determined. The harmonic measurement data (the harmonic waveform data) is determined from the 1st order (the fundamental wave).

Maximum Harmonic Order to Be Measured (Max Order)

You can select a value between 1 and 500.

However, the maximum measurable harmonic order is the smallest of the three orders listed below.

- The specified maximum harmonic order to be measured
- The value determined automatically according to the PLL source frequency (see section 6.6 in the getting started guide, IM WT1801-03EN)
- When the data update interval is 50 ms, the maximum measurable harmonic order is 100.

The numeric data corresponding to harmonic orders above the maximum measurable harmonic order is displayed as “-------” (no data).

- If the minimum harmonic order to be measured is set to 1, the data of the DC component is not included when the distortion factor is determined.
- There is no overload value indication (“-OL-”) or zero indication (suppression to zero) for the numeric data of harmonic orders 0 (DC) to 500. For information about the overload value indication (“-OL-”) and zero indication (suppression to zero) in normal measurement, see section 6.4 in the getting started guide, IM WT1801-03EN.

Distortion Factor Equation (Thd Formula)

When determining the harmonic measurement functions Uhdf, Ihdf, Phdf, Uthd, Ithd, and Pthd, you can select to use one of the denominators described below as the denominator for the equation. For information about equations, see appendix 1 in the getting started guide, IM WT1801-03EN.

1/Total

The denominator is the measured data of all orders from the minimum measured order (0 or 1st) to the maximum measured order (within the upper limit of harmonic analysis).

1/Fundamental

The denominator is the data of the fundamental signal component (1st order).

Input Element Group (Element Settings)

This setting appears on models with the simultaneous dual harmonic measurement option. You can divide all the input elements into two groups: Hrm1 and Hrm2, and measure harmonics using two PLL sources with different frequencies. You can measure the input and output harmonics of an AC–AC converter whose input and output frequencies are different.
This setting does not appear on models with the harmonic measurement option.

Element1 to Element6

Use the soft keys to select an element, and then assign the element to group Hrm1 or group Hrm2. Input elements that are assigned to the same wiring unit are assigned to the same group.

PLL Source of Group Hrm1 (Hrm1 PLL Source)
PLL Source of Group Hrm2 (Hrm2 PLL Source)

These settings are the same as the PLL source (PLL Source) setting.

▶ **Click here.**

Measured Harmonic Orders of Group Hrm1 (Min Order/Max Order)
Measured Harmonic Orders of Group Hrm2 (Min Order/Max Order)

These settings are the same as the measured harmonic orders (Min Order/Max Order) setting.

▶ **Click here.**

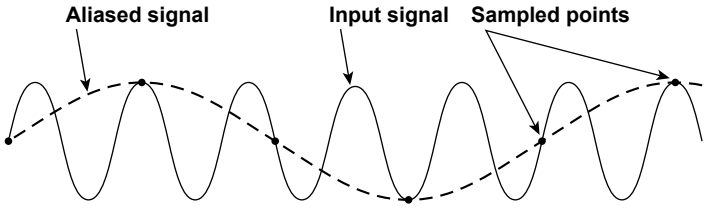
Distortion Factor Equation of Group Hrm1 (Thd Formula)
Distortion Factor Equation of Group Hrm2 (Thd Formula)

These settings are the same as the distortion factor equation (Thd Formula) setting.

▶ **Click here.**

Anti-Aliasing Filter

When an FFT is taken through the performance of A/D conversion on a repetitive waveform, a phenomenon occurs in which frequency components that exceed half the frequency of the sampling frequency are detected as low frequency components. This is called aliasing.



Aliasing causes problems such as increased errors in measured values and incorrect measurements of the phase angles on each harmonic. An anti-aliasing filter is used to prevent aliasing and eliminate high frequency components that are irrelevant to the harmonic measurement.
For example, when an input signal with a fundamental frequency of 50 Hz is measured up to the 50th order, the frequency of the 50th order is 2.5 kHz. Thus, a 5-kHz anti-aliasing filter is used to eliminate high frequency components that are greater than or equal to approximately 5 kHz, which are irrelevant to harmonic measurement.

The WT1800 uses the line filter as an anti-aliasing filter for harmonic measurements. For information about how to configure the filter, see “Line Filter (LINE FILTER).”

▶ **Click here.**

The accuracy and the upper limit of the measurement bandwidth change when the anti-aliasing filter (line filter) is turned ON. For details, see appendix 6.6 in the getting started guide, IM WT1801-03EN.

4 Motor Evaluation Conditions (Option)

Motor Evaluation Conditions and Auxiliary Input Conditions (MOTOR/AUX SET)

Press MOTOR/AUX SET to display a setup dialog box for the installed option.

Models with the Motor Evaluation Option

The MOTOR Settings dialog box appears.

The WT1800 can determine the motor rotating speed, torque, and output. It determines them using the revolution sensor signal, which is proportional to the motor rotating speed, and the torque meter signal, which is proportional to the motor torque. You can configure the WT1800 to receive analog (DC voltage) signals or pulse signals from the revolution sensor and torque meter. Also, you can set the number of motor poles and determine the motor's synchronous speed and slip. Furthermore, you can use the active power, frequency, and motor output measured by the WT1800 to compute the motor efficiency and total efficiency.

For a list of the measurement functions that can be measured with the motor evaluation feature and their descriptions, see "Motor Evaluation Functions" under "Items That This Instrument Can Measure."

▶ **Click here.**

Models with the Auxiliary Input Option

The Aux Settings dialog box appears.

▶ **Click here.**

Motor Evaluation Settings

You can configure the following motor evaluation settings.

- Scaling factor (Scaling)
- Unit (Unit)
- Input signal type (Sense Type)
- Analog input range
- Linear scaling of analog input
- Line Filter (Line Filter)
- Synchronization Source (Sync Source)
- Pulse input range
- Torque signal pulse rating
- Revolution signal pulses per revolution (Pulse N)
- Motor poles (Pole)
- Frequency measurement source (Source)
- Electrical angle measurement (Electrical Angle Measurement)*
- Motor efficiency and total efficiency computation

* This item is available on models with the harmonic measurement option or the simultaneous dual harmonic measurement option.

Scaling Factor (Scaling)

Setting the Scaling Factor for Scaling the Revolution Signal

You can set the factor for scaling the revolution signal. Set the factor to a value from 0.0001 to 99999.9999.

- **When the Revolution Signal Type is Analog**

  This setting is used as the scaling factor in the equation for the linear scaling of analog input.

- **When the Revolution Signal Type is Pulse**

  This setting is used as the scaling factor in the equation for the number of revolution signal pulses per revolution.

Setting the Scaling Factor for Scaling the Torque Signal

You can set the factor for scaling the torque signal to motor torque. Set the factor to a value from 0.0001 to 99999.9999.

- **When the Torque Signal Type is Analog**
  This setting is used as the scaling factor in the equation for the linear scaling of analog input.
- **When the Torque Signal Type is Pulse**
  This setting is used as the scaling factor in the equation for the torque signal pulse rating.

Setting the Scaling Factor for Computing the Motor Output

You can specify the scaling factor for computing the motor output (mechanical power) from the rotating speed and torque. Set the factor to a value from 0.0001 to 99999.9999.
The equation is indicated below. The scaling factors of the rotating speed and torque are set so that the unit of the rotating speed is min^{-1} (or rpm) and the unit of torque is N•m. When the scaling factor of the motor output specified here is 1, the unit of the motor output Pm is W. Because the efficiency computation uses W as the unit of Pm, we recommend that you set the scaling factor of each item so that the unit of Pm is W.

$$\text{Motor output Pm} = \frac{2\pi}{60} \times \text{Speed} \times \text{Torque} \times S$$

Speed: The rotating speed, determined from the number of pulses per revolution
Torque: The torque, determined from the torque signal pulse rating
S: The scaling factor

Unit (Unit)

- Number of characters: Up to eight
- Usable characters: Spaces and all characters that are displayed on the keyboard

Input Signal Type (Sense Type)

You can select which of the following two types of signals you want the WT1800 to receive from the revolution sensor and torque meter.

- Analog: Select this option when the WT1800 will receive DC voltage (analog) signals.
- Pulse: Select this option when the WT1800 will receive pulse signals.

Settings for Different Signal Types

As indicated below, the settings that you need to configure vary depending on the revolution and torque signal type.

Settings Related to the Signal Type

Setting	Signal Type	
	Analog	Pulse
Analog auto range	Yes	No
Analog range	Yes	No
Linear scale A, B	Yes	No
Line filter	Yes	No
Synchronization source	—	—
Pulse range	No	Yes
Number of pulses per revolution	No	Yes

Yes: Must be set.
No: Does not need to be set.
—: Measurement can be performed when the sync source is set to None (the default setting), but you can increase synchronicity with power measurement by specifying a sync source.

Common Settings Unrelated to the Signal Type

- Scaling factor
- Unit
- Motor poles
- Sync speed frequency measurement source

Analog Input Range

Set the analog input range for input signals whose type has been set to analog. For input signals whose type has been set to pulse, there is no need to set the analog input range.

Turning Auto Range On and Off (Analog Auto Range)

Select whether to turn auto range on or off. When auto range is on, the WT1800 automatically switches between the following ranges according to the size of the input signal.
20 V, 10 V, 5 V, 2 V, and 1 V

Range Increase

- The measurement range is increased when the rotating speed signal or torque signal exceeds 110% of the measurement range.
- The measurement range is increased when the peak value of the input signal exceeds 150% of the measurement range.

Range Decrease

The measurement range is decreased when the rotating speed signal or torque signal falls below 30% of the measurement range and the peak value of the input signal is less than 125% of the lower range.

When non-periodic pulse waveforms are applied during auto range, the range may not remain constant. If this happens, use the fixed range setting.

Fixed Range (Analog Range)

You can select one of the following input ranges.
20 V, 10 V, 5 V, 2 V, or 1 V

Linear Scaling of Analog Input

You can set the slope and the offset value of the input signal using one of the following two methods.

- Set the values manually.
- Specify two points, and use those points to compute the values

Manually Setting the Input Signal Slope and Offset (Linear Scale A, B)

You can set the slope (A) and offset (B) of the rotating speed and torque input signals to values within the following ranges.
A: 1.000 m to 1.000 M
B: –1.000 M to 1.000 M
The following equation is used to compute the rotating speed and torque.

Rotating speed, torque = S(AX + B) – NULL

S: The scaling factor
A: The input signal slope
X: The input voltage from the revolution sensor or torque meter.
B: The offset
NULL: The NULL value

When There Is No Offset in the Input Voltages from the Revolution Sensor and Torque Meter

If you set A to 1 and B to 0, the linear scaling settings do not affect computation, and the previous equation becomes:

Rotating speed, torque = SX – NULL

You can compute the rotating speed and torque by setting the scaling factors to the number of revolutions and the amount of torque per 1 V.

When There Is Offset in the Input Voltages from the Revolution Sensor and Torque Meter

If you set S to 1, the scaling factor does not affect the computation, and the previous equation becomes

Rotating speed, torque = AX + B – NULL

You can compute the rotating speed and torque by setting the offset values (B) and setting the input signal slopes (A) to the number of revolutions and the amount of torque per 1 V.

If you enable the NULL function and then change the input signal slope (A) or offset value (B), NULL correction will be offset. Reset the NULL value.

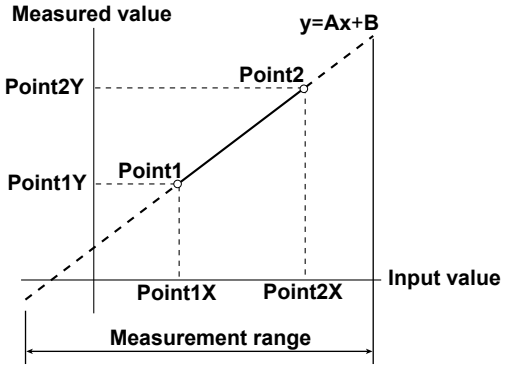
Computing the Input Signal Slope and Offset by Specifying Two Points (Calculation)

On the input characteristic graphs of the rotating speed and torque, you can specify two measured rpm or N•m values (Point1Y and Point2Y) in relation to two input voltage values (Point1X and Point2X).

Measured values (Point1X and Point2X): –1.000 T to 1.000 T

Computed values (Point1Y and Point2Y): –1.000 T to 1.000 T

Select Execute to use these four values to determine and set the input signal slope (A) and offset (B).



Line Filter (Line Filter)

You can remove high-frequency noise by inserting a line filter into the circuit used to measure the revolution and torque signals.

You can select the cutoff frequency from the following options.

OFF, 100 Hz, and 1 kHz

Selecting OFF disables the filter.

The line filter setting applies to input signals whose type has been set to analog. For input signals whose type has been set to pulse, there is no need to configure this setting.

Synchronization Source (Sync Source)

- When you are measuring analog revolution and torque signals, you can select the element to use as the sync source from the following options. The available options vary depending on the installed elements.
  U1, I1, U2, I2, U3, I3, U4, I4, U5, I5, U6, I6, Ext Clk (external clock),* and None
  * For the EXT CLK connector specifications, see section 4.3 in the getting started guide, IM WT1801-03EN.
- The measurement period is determined according to the zero-crossing point of the selected synchronization source. The WT1800 uses the measurement period to measure the analog revolution and torque signals.
  If you specify no synchronization source by selecting “None,” all the sampled data within the data update interval is used to determine the rotating speed and torque.
- When the revolution or torque signal is a pulse signal, its value is the pulse signal period averaged over the measurement period. The measurement period is determined according to the sync source. If the pulse signal period does not fit within the measurement period, the previous period is used to determine the measured value.
- To achieve stable motor efficiency measurements, we recommend that you set the sync source for motor efficiency measurement to the same sync source that is set in the fundamental measurement conditions. This ensures that the measurement period is in sync with the measurement functions, such as those for voltage, current, and active power.

Pulse Input Range

Set an appropriate range for the maximum and minimum input signal values. For example, when you are measuring signals for rotating speeds of 120 rpm to 180 rpm and torques of –18 N•m to +18 N•m, set the rotating speed pulse input range to 100 rpm to 200 rpm, and set the torque pulse input range to –20 N•m to +20 N•m.

Upper and Lower Limits ((Pulse Range Upper, Pulse Range Lower)

You can set the pulse range for each input signal within the following limits.

- Revolution signal: 0.0000 to 99999.9999 (rpm)
- Torque signal: –10000.0000 to 10000.0000 (N•m)

When the input signal type is pulse, the waveform display lower and upper limits are the values that you set here.

On models with the D/A output option, the rated D/A output values are as follows.

Revolution and Torque Input Signals	D/A output
Setting for Pulse Range Upper	+5 V
Setting for Pulse Range Upper × (–1)	–5 V

Torque Signal Pulse Rating

When the torque signal type is pulse, refer to the torque meter’s specifications to set its rated positive and negative values.

Positive and Negative Rated Torque Signal Values (Rated Upper, Rated Lower)

Range: –10000.0000 to 10000.0000 (N•m)

Positive and Negative Rated Torque Signal Pulse Frequencies (Rated Freq Upper, Rated Freq Lower)

Range: 1 to 100000000 (Hz)

The following equation is used to compute the torque.
Torque = S(AX + B) – NULL

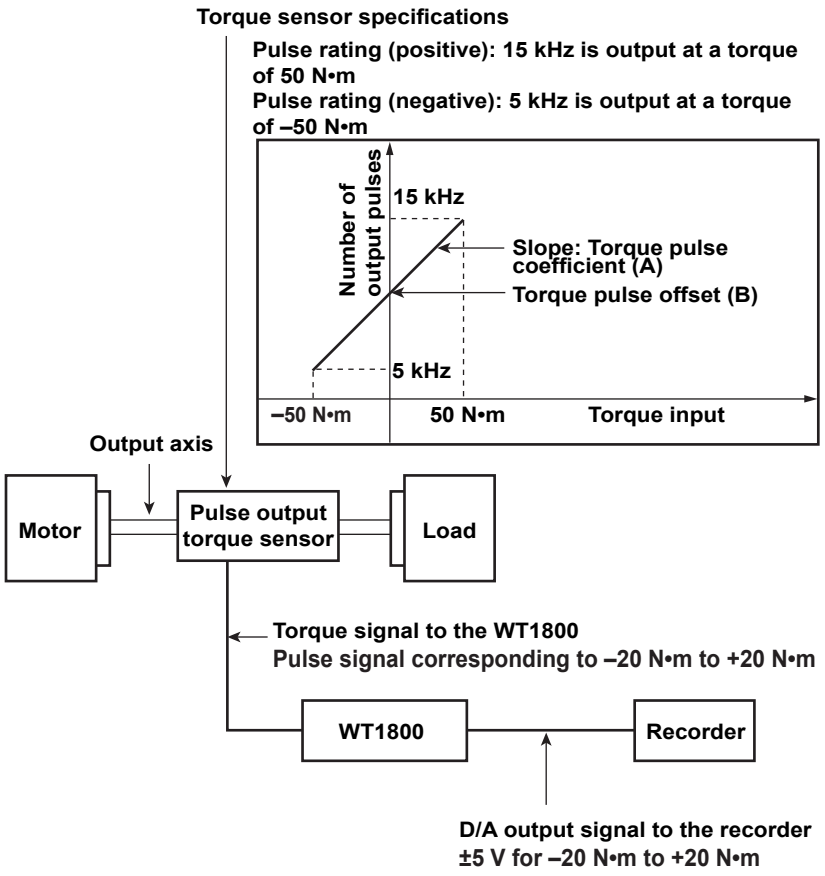
S: The scaling factor[1]
A: The torque pulse coefficient[2]
X: The pulse frequency
B: The torque pulse offset[2]
NULL: The NULL value

1 If the torque signal is a changed signal, you can set the scaling factor to determine the torque before the change.
2 The torque pulse coefficient and torque pulse offset are determined from the torque signal pulse rating as shown in the next figure.

Relationship between the Torque Signal Pulse Input Range and Pulse Rating

To measure a torque of –20 N•m to +20 N•m using a torque meter with specifications in the figure below, configure the pulse input range and pulse rating settings as indicated below.

- Upper limit of the pulse input range (Pulse Range Upper): 20.0000
- Lower limit of the pulse input range (Pulse Range Lower): –20.0000
- Positive rated torque signal value (Rated Upper): 50.0000
- Negative rated torque signal value (Rated Lower): –50.0000
- Positive rated torque signal pulse frequency (Rated Freq Upper): 15000
- Negative rated torque signal pulse frequency (Rated Freq Lower): 5000


Torque sensor specifications
Pulse rating (positive): 15 kHz is output at a torque of 50 N•m
Pulse rating (negative): 5 kHz is output at a torque of –50 N•m
Number of output pulses
15 kHz
5 kHz
Slope: Torque pulse coefficient (A)
Torque pulse offset (B)
–50 N•m
50 N•m
Torque input
Output axis
Motor
Pulse output torque sensor
Load
Torque signal to the WT1800
Pulse signal corresponding to –20 N•m to +20 N•m
WT1800
Recorder
D/A output signal to the recorder
±5 V for –20 N•m to +20 N•m

The pulse input range setting applies to input signals whose type has been set to pulse. For input signals whose type has been set to analog, there is no need to configure this setting.

Revolution signal pulses per revolution (Pulse N)

Set the number of pulses per revolution to a value from 1 to 9999.
The following equation is used to compute the rotating speed.

$$\text{Rotating speed} = S\frac{X}{N} - \text{NULL}$$

S: The scaling factor*
X: The number of input pulses from the revolution sensor per minute
N: The number of pulses per revolution
NULL: The NULL value

* When the scaling factor is 1, the rotating speed is the number of revolutions per minute (min^{-1} or rpm). If the revolution signal is a changed signal, you can set the scaling factor to determine the rotating speed before the change.

The setting specifying the number of revolution signal pulses per revolution applies to input signals whose type has been set to pulse. For input signals whose type has been set to analog, there is no need to configure this setting.

Synchronous Speed (Sync Speed)

Motor Poles (Pole)

Set the number of motor poles to a value from 1 to 99. This number is used to compute the sync speed.

Frequency Measurement Source (Source)

- Select the frequency measurement source to use to compute the sync speed from the options below. The frequency measurement source is used to compute the sync speed. The available options vary depending on the installed elements.
  U1, I1, U2, I2, U3, I3, U4, I4, U5, I5, U6, and I6
- On models that do not have the add-on frequency measurement option installed, select a voltage or current whose frequency is being measured (voltage/current to measure the frequency of). If you select a voltage or current whose frequency is not being measured, an error will occur.
- Normally, you should select the voltage or current that is being applied to the motor and whose frequency is being measured. If you select the frequency of a voltage or current that is not being applied to the motor, the sync speed may not be determined properly.

Sync Speed Equation

The sync speed unit is fixed at min^{-1} or rpm.

$$\text{Sync speed } (min^{-1}) = \frac{120 \times Fs}{Pole}$$

Fs: The frequency of the frequency measurement source (Hz)
Pole: The number of motor poles

Slip Equation

The sync speed unit is fixed at min^{-1} or rpm. To determine the slip, configure the rotating speed scaling factor so that the unit of the rotating speed is also min^{-1} (or rpm).

$$\text{Slip (\%)} = \frac{\text{SyncSp} - \text{Speed}}{\text{SyncSp}} \times 100$$

SyncSp: The synchronous speed (min^{-1})
Speed: The rotating speed (min^{-1})

Set the frequency measurement source to a stable voltage or current signal that is being applied to the motor and that has low distortion and noise.

Electrical Angle Measurement (Electrical Angle Measurement)

This item is appears on models with the harmonic measurement option or the simultaneous dual harmonic measurement option.

Turning Electrical Angle Measurement On and Off

Select whether to measure electrical angles.

Electrical Angle Correction (Electrical Angle Correction)

Set the electrical angle correction value.

Correction Value (Correction Value)

Set the correction value to a number from –180.00° to 180.00°.

Clearing the Correction Value (Clear Correction)

Set the correction value to 0.00.

Automatically Computing the Correction Value (Auto Enter Correction)

The WT1800 automatically sets the correction value to the difference between the phase of the voltage or current whose correction value is being automatically computed and the current electrical angle phase.

Voltage or Current to Automatically Compute the Correction Value of (Auto Enter Target)

Select the voltage or current to automatically compute the correction value of from the options below. The available options vary depending on the installed elements.
U1, I1, U2, I2, U3, I3, U4, I4, U5, I5, U6, and I6

Motor Efficiency and Total Efficiency Computation

The WT1800 can compute the motor efficiency (the ratio of power consumption to motor output) and total efficiency from the active power and motor output that it measures.* You can set the efficiency equation using the η Formula setting.

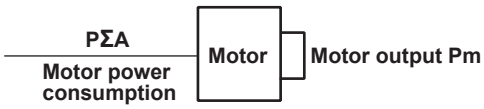
▶ Click here.

* The total efficiency is the ratio of total power consumption—not just the power consumption of the motor but also the power consumption of the converter that supplies the motor with power—to motor output.

The following is an example of how the values are computed.

When the Motor Input Is Wired to ΣA

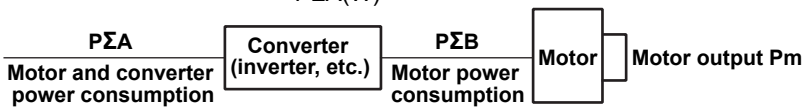
$$\text{Motor efficiency (\%)} = \frac{\text{Motor output Pm (W)}}{\text{PΣA(W)}} \times 100$$



When the Converter and Motor Inputs Are Wired to ΣA and ΣB, Respectively

$$\text{Motor efficiency (\%)} = \frac{\text{Motor output Pm (W)}}{\text{PΣB(W)}} \times 100$$

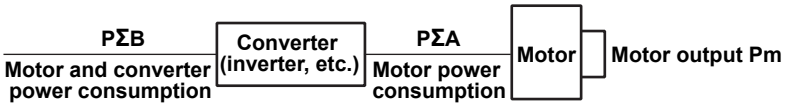
$$\text{Total efficiency (\%)} = \frac{\text{Motor output Pm (W)}}{\text{PΣA(W)}} \times 100$$



When the Converter and Motor Inputs Are Wired to ΣB and ΣA, Respectively

$$\text{Motor efficiency (\%)} = \frac{\text{Motor output Pm (W)}}{\text{PΣA(W)}} \times 100$$

$$\text{Total efficiency (\%)} = \frac{\text{Motor output Pm (W)}}{\text{PΣB(W)}} \times 100$$



If ΣA or ΣB is a three-phase, three-wire (3P3W) system, you can use delta computation to perform 3P3W>3V3A transformation on ΣA and ΣB. From the 3P3W>3V3A transformation, you can determine one unmeasured line voltage and one unmeasured common mode current.

5 Auxiliary Input Conditions (Option)

Auxiliary Input Conditions (MOTOR/AUX SET)

You can apply the signals of sensors, such as luminance, wind-power, or temperature sensors, to the AUX1 and AUX2 connectors, and display the physical values measured by the sensors. You can configure the following auxiliary input settings.

- Input signal name (Aux Name)
- Scaling factor (Scaling)
- Unit (Unit)
- Analog input range
- Linear scaling of analog input
- Line filter (Line Filter)

Input Signal Name (Aux Name)

- Number of characters: Up to eight
- Usable characters: Spaces and all characters that are displayed on the keyboard

Scaling Factor (Scaling)

You can set the factor for scaling the auxiliary input. Set the factor to a value from 0.0001 to 99999.9999. This setting is used as the scaling factor in the equation for the linear scaling of analog input.

Unit (Unit)

This setting is the same as the input signal name (Aux Name) setting.

▶ **Click here.**

Analog Input Range

Set the auxiliary input (analog input) range.

Turning Auto Range On and Off (Analog Auto Range)

Select whether to turn auto range on or off. When auto range is on, the WT1800 automatically switches between the following ranges according to the size of the auxiliary input.
20 V, 10 V, 5 V, 2 V, 1 V, 500 mV, 200 mV, 100 mV, and 50 mV

Range Increase

- The measurement range is increased when the auxiliary input exceeds 110% of the measurement range.
- The measurement range is increased when the peak value of the auxiliary input exceeds 150% of the measurement range.

Range Decrease

The measurement range is decreased when auxiliary input falls below 30% of the measurement range and the peak value of the auxiliary input is less than 125% of the lower range.

When non-periodic pulse waveforms are applied during auto range, the range may not remain constant. If this happens, use the fixed range setting.

Fixed Range (Analog Range)

You can select one of the following input ranges.
20 V, 10 V, 5 V, 2 V, 1 V, 500 mV, 200 mV, 100 mV, and 50 mV

Linear Scaling of Analog Input

You can set the slope and the offset value of the auxiliary input using one of the following two methods.

- Set the values manually.
- Specify two points, and use those points to compute the values

Manually Setting the Auxiliary Input Slope and Offset (Linear Scale A, B)

You can set the slope (A) and offset (B) of the auxiliary input to values within the following ranges.

A: 1.000 m to 1.000 M

B: –1.000 M to 1.000 M

The following equation is used to compute measured values of the auxiliary input.

Auxiliary input measured value = S(AX + B) – NULL

S: The scaling factor
A: The auxiliary input slope
X: The input voltage of the auxiliary input
B: The offset
NULL: The NULL value

When There Is No Offset in the Auxiliary Input Voltage

If you set A to 1 and B to 0, the linear scaling settings do not affect computation, and the previous equation becomes:

Auxiliary input measured value = SX – NULL

You can scale the auxiliary input by setting the scaling factor to the number of units per 1 V.

When There Is Offset in the Auxiliary Input Voltage

If you set S to 1, the scaling factor does not affect the computation, and the previous equation becomes:

Auxiliary input measured value = AX + B – NULL

You can scale the auxiliary input by setting the offset value (B) and setting the auxiliary input slope (A) to the number of units per 1 V.

If you enable the NULL function and then change the auxiliary input slope (A) or offset value (B), NULL correction will be offset. Reset the NULL value.

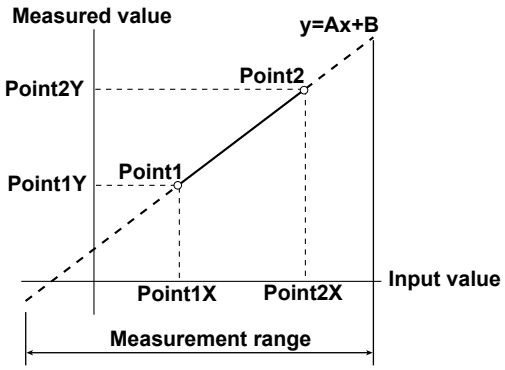
Computing the Auxiliary Input Slope and Offset by Specifying Two Points (Calculation)

On the input characteristic graph of the external input signal, you can specify two measured unit values (Point1Y and Point2Y) in relation to two input voltage values (Point1X and Point2X). Select Execute to use these four values to determine and set the auxiliary input slope (A) and offset (B).

Measured values (Point1X and Point2X): –1.000 T to 1.000 T

Computed values (Point1Y and Point2Y): –1.000 T to 1.000 T

Select Execute to use these four values to determine and set the auxiliary input slope (A) and offset (B).



Line Filter (Line Filter)

You can remove high-frequency noise by inserting a line filter into the circuit used to measure the Aux1 and Aux2 auxiliary inputs.

You can select the cutoff frequency from the following options.

OFF, 100 Hz, and 1 kHz

Selecting OFF disables the filter.

6 Holding Measured Values and Performing Single Measurements

Holding Measured Values (HOLD)

The hold operation stops data measurement and display operations for each data update interval and holds the display of all measurement function data. The D/A output values, the values in the data lists printed by the built-in printer, and the communication values all reflect the held values.

For information about how holding works during integration, see the sections on holding and releasing integration.

▶ Click here.

Single Measurement (SINGLE)

While the display is held, the signal is measured once at the data update interval, and then the display is re-held. If you press SINGLE when the display is not held, measurement restarts from that point.

Using an External Signal to Hold Measured Values and Perform Single Measurements (Option)

On models with the 20-channel D/A output option, you can use the remote control feature to hold measured values and perform single measurements. For details about the remote control feature, see appendix 4.6 in the getting started guide, IM WT1801-03EN.

7 Numeric Data Display

Numeric Data Display (NUMERIC)

You can press NUMERIC to make the numeric data display appear.

Each time you press NUMERIC the display format switches in order between 4 Items, 8 Items, 16 Items, Matrix, All Items, Hrm List Single, Hrm List Dual, and Custom.

Display Format (FORM)

The display format options vary depending on the current display.

- Numeric data display format
- Waveform display format
- Trend display format
- Bar graph display format
- Vector display format
- Setup parameter list display format
- High speed data capturing settings

Numeric Data Display Format

You can select the number of numeric data items that are displayed simultaneously from the choices below or choose to display a list of items.

4-Value Display (4 Items)

Four numeric data values are displayed in one column.

8-Value Display (8 Items)

- When the display mode is Numeric, eight numeric data values are displayed in one column.
- When the display is split, eight numeric data values are displayed in two columns.

16-Value Display (16 Items)

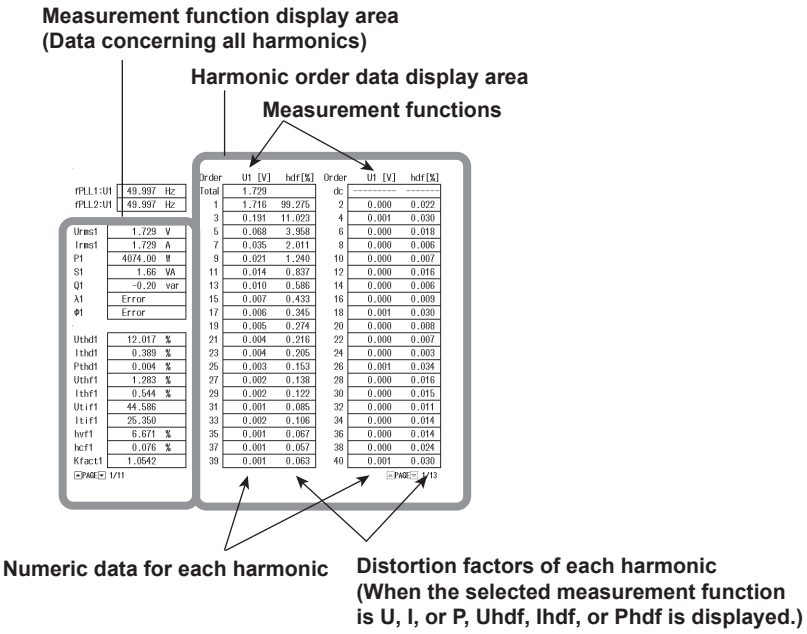
Sixteen numeric data values are displayed in two columns.

Matrix (Matrix) and All (All Items) Displays

A table of numeric data is displayed with measurement functions listed vertically and symbols indicating elements and wiring units listed horizontally. The number of displayed items varies depending on the number of elements that are installed in the WT1800.

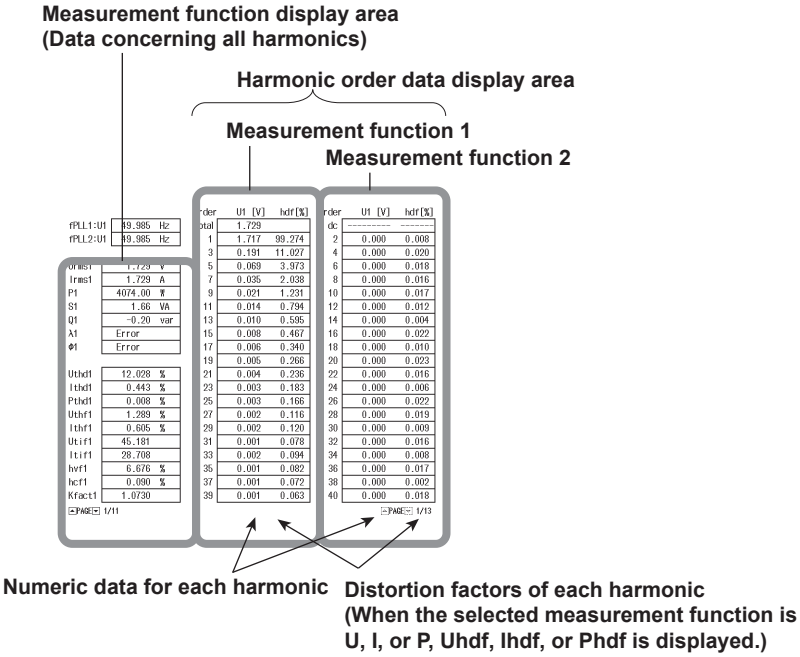
Single Harmonics List Display (Hrm List Single; option)

- When the display mode is Numeric, up to 42 of the harmonic order data items of a single measurement function are displayed in two columns.
- When the display is split, up to 22 of the harmonic order data items of a single measurement function are displayed in two columns.


Measurement function display area
(Data concerning all harmonics)
Harmonic order data display area
Measurement functions
Numeric data for each harmonic
Distortion factors of each harmonic
(When the selected measurement function
is U, I, or P, Uhdf, Ihdf, or Phdf is displayed.)

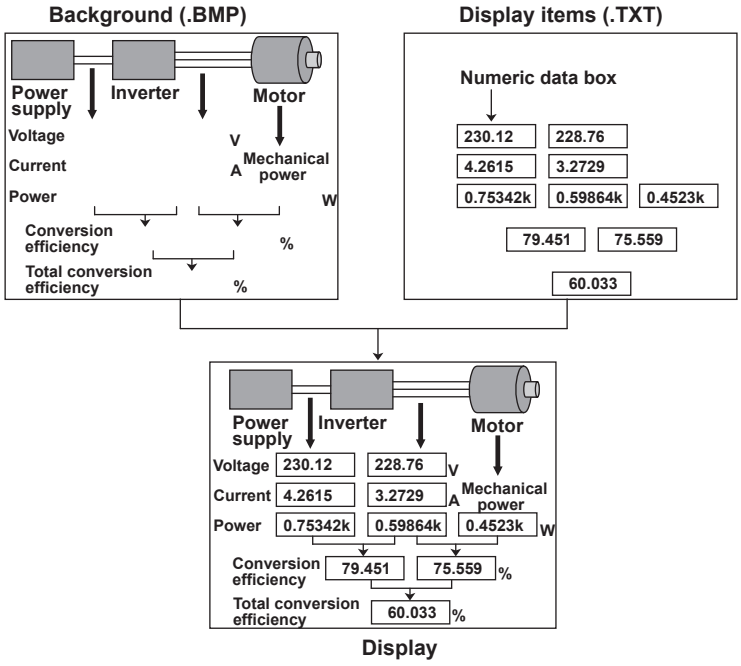
Dual Harmonics List Display (Hrm List Dual; option)

- When the display mode is Numeric, the numeric values of two measurement functions are displayed in two separate columns, each containing up to 22 numeric values.
- When the display is split, the numeric values of two measurement function are displayed in two separate columns, each containing up to 12 numeric values.


Measurement function display area
(Data concerning all harmonics)
Harmonic order data display area
Measurement function 1
Measurement function 2
Numeric data for each harmonic
Distortion factors of each harmonic
(When the selected measurement function is
U, I, or P, Uhdf, Ihdf, or Phdf is displayed.)

Custom Display (Custom)

You can use an illustration (.BMP) or picture (.BMP) from a PC or other device as the background of the display. You can arrange numeric data boxes on top of this background to create a custom display. Numeric data appears in this custom display.



Switching the Displayed Page (PAGE UP/PAGE DOWN)

You can switch the displayed page and display a new set of items.

- PAGE▼: The next page is displayed.
- PAGE▲: The previous page is displayed.

In the 4-, 8-, and 16-Value Displays

You can switch between and display pages 1 to 12.

In the Matrix Display

You can switch between and display pages 1 to 9.

In the All Items Display

The first page is always displayed in the top half of the screen. You can switch between pages 2 and later pages in the bottom half of the screen. When the display is split and the All Items display is shown, you can switch between all pages, including page 1, in order.

In the Single Harmonics List and Dual Harmonics List Displays

You can switch separately between the pages of the measurement function display (on the left side of the screen) and the harmonic order data display (on the right side of the screen). Use the left and right cursor keys to select the display whose pages you want to switch between.

In the Custom Display

When you have configured the custom display to contain multiple pages, you can switch between each of the pages.

Jumping to the First or Last Page (PAGE TOP/PAGE END)

- ⏬: The last page is displayed.
- ⏫: The first page is displayed.

Number of Displayed Digits (Display Resolution)

The number of displayed digits (display resolution) for voltage, current, active power, apparent power, reactive power, and so on is as follows:

- If the value is less than or equal to 60000: Five digits.
- If the value is greater than 60000: Four digits.

For details, see appendix 4 in the getting started guide, IM WT1801-03EN. When the range rating (rated value of the specified measurement range) is specified, the Σ functions of the voltage, current, active power, apparent power, reactive power, and so on, are set to the decimal place and unit of the element with the lowest number of displayed digits (display resolution) in the wiring unit. For details about the display resolution during integration, see “Number of Displayed Digits (Display Resolution)” under “Integrated Power (Watt hours).”

▶ **Click here.**

Display Item (ITEM)

The display item options vary depending on the current display.

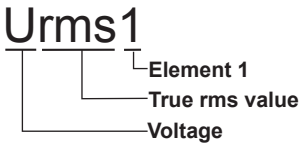
- Numeric data display format
  - 4-, 8-, and 16-value displays (4 Items/8 Items/16Items)
  - Matrix display (Matrix)
  - All Items display (All Items)
  - Single Harmonics and Dual Harmonics Lists (Hrm List Single/Dual; option)
  - Custom display (Custom)
- Waveform display items
- Trend display items
- Bar graph display items
- Vector display items
- High speed data capturing display items

For a list of the measurement functions and their descriptions, see “Items That This Instrument Can Measure.”

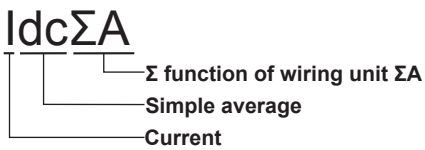
▶ **Click here.**

Example of How Measurement Functions Are Displayed in the Numeric Data Display

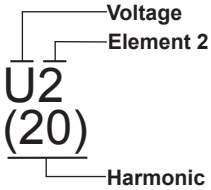
True rms voltage of element 1



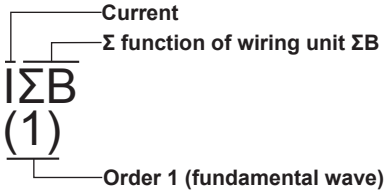
Simple average of the currents of the elements in wiring unit ΣA



Voltage of the 20th order of element 2



Simple average of the fundamental currents of the elements in wiring unit ΣB



Notes about the Numeric Data Display

- "-------" is displayed if a measurement function is not selected or if there is no numeric data.
- If Urms, Umn, Udc, Urmn, Uac, Irms, Imn, Idc, Irmn, or Iac exceeds 140% of the measurement range, "-OL-" is displayed to indicate an overload value.
- If the voltage or current exceeds 140% of the measurement range, "-OL-" is displayed to indicate an overload value for P.
- If the measured or computed result cannot be displayed using the specified decimal place or unit, "-OF-" (for overflow) is displayed.
- When the measured voltage or current value is at or below the percentage of the measurement range indicated below, the values of Urms, Umn, Urmn, Irms, Imn, Irmn, and other measurement functions that are based on them are displayed as zero. The λ and Φ functions will return errors ("Error" is displayed).
  - When the Crest Factor Is Set to CF3
    When Urms, Uac, Irms, or Iac is 0.5% or less When Umn, Urmn, Imn, or Irmn is 2% or less
  - When the Crest Factor Is Set to CF6
    When Urms, Uac, Irms, or Iac is 1.0% or less When Umn, Urmn, Imn, or Irmn is 4% or less
- If the analysis window width (number of cycles of the fundamental signal) that is determined by the fundamental frequency is shorter than the data update interval, harmonic data is not measured, and "-------" (no data) is displayed. If this happens, increase the data update interval. For example, if the data update interval is 50 ms and the fundamental frequency is 10 Hz (the period is 100 ms), the analysis window will be 1 wave wide (see section 6.6 in the getting started guide, IM WT1801-03EN), and the data measurement interval will be 100 ms. In this case, the time required for harmonic measurement is approximately 150 ms or greater (data measurement interval + data processing time). To measure and display harmonic data, set the data update interval to a value greater than or equal to 200 ms.
- There is no overload value indication ("-OL-") or zero indication (suppression to zero) for the numeric data of harmonic orders 0 (DC) to 500.
- If the measured frequency is outside the measurement range, the fU or fI function returns an error ("Error" is displayed).
- If the power factor λ is greater than 1 and less than or equal to 2, λ returns 1. Φ returns zero.
- If λ is greater than 2, λ and Φ return errors ("Error" is displayed).

4-, 8-, and 16-Value Displays (4 Items/8 Items/16Items)

Item Number to Set (Item No.)

Select the number of the item that you want to configure.

Function (Function)

You can select any of the measurement function types listed under "Items That This Instrument Can Measure."

▶ **Click here.**

If you select None, no measurement function is displayed for the selected item.

Direct Function Selection (U/I/P, S/Q/λ/Φ, WP/q/TIME, FU/FI/η, and U/I MODE)

When the menu is not displayed, you can change which of the selected measurement functions is displayed using the function select keys (U/I/P, S/Q/λ/Φ, WP/q/TIME, FU/FI/η, and U/I MODE).

U/I/P, S/Q/λ/Φ, WP/q/TIME, and FU/FI/η

Each time you press U/I/P, the selected function switches in order between U, I, and P. The same is true for S/Q/λ/Φ, WP/q/TIME, and FU/FI/η.

U/I MODE

Each time you press the key, measurement function U or I switches in order between rms, mean, dc, rmean, and ac.

Element (Element/Σ)

- You can select the element/wiring unit from the options below. The available options vary depending on the installed elements.
  Element1, Element2, Element3, Element4, Element5, Element6, ΣA, ΣB, and ΣC
- If the selected wiring unit does not have any elements assigned to it, because there is no data, "-------" (no data) is displayed. For example, if elements are assigned to ΣA but not to ΣB, the measurement function for ΣB is displayed as "-------" (no data).

Directly Selecting Elements (ELEMENT)

When the menu is not displayed, you can change the element number of the selected measurement function by pressing ELEMENT.

Changing Elements Simultaneously (ALL)

You can change the elements and wiring units of all displayed items at once. The ALL indicator illuminates.

Order (Order; option)

When you select a function that has harmonic data, you can set the displayed harmonic order within the following range.
Total (Total value) or 0 (dc) to 500

The orders that can be specified vary depending on the measurement function. For details, see "Harmonic Measurement Function Orders."

▶ **Click here.**

The numeric data corresponding to harmonic orders above the maximum measurable harmonic order is displayed as "-------" (no data). For information about the maximum measurable harmonic order, see "Maximum Harmonic Order to Be Measured (Max Order)."

▶ **Click here.**

Resetting the Display Items (Reset Items)

Reset Patterns (Reset Pattern)

You can select the reset method from the following options.

- Element Origin: The numeric data for each element is displayed on each page. The pattern that the data is arranged in varies depending on the number of installed elements.
- Function Origin: The numeric data for each function is displayed on each page. The pattern that the data is arranged in varies depending on the number of installed elements.
- Clear Current Page: All the display items on the current page are set to None.
- Clear All Pages: All the display items on every page are set to None.

Resetting the Items (Reset Items Exec)

Reset the items.

Turning the Display Frame On and Off (Display Frame)

Set whether to show the display frame.

Matrix display (Matrix)

Item Number to Set (Item No.)

This is the same as setting the item number in the 4-, 8-, and 16-value displays.

▶ Click here.

Function (Function)

This is the same as setting the function in the 4-, 8-, and 16-value displays.

▶ Click here.

In the matrix display, if you choose a measurement function that does not require an element or wiring unit (such as η1 to η4, F1 to F20, Ev1 to Ev8, etc.), data is displayed in the first column.

Direct Function Selection (U/I/P, S/Q/λ/Φ, WP/q/TIME, FU/FI/η, and U/I MODE)

This is the same as direct function selection in the 4-, 8-, and 16-value displays.

▶ Click here.

Order (Order; option)

This is the same as setting the order in the 4-, 8-, and 16-value displays.

▶ Click here.

Resetting the Display Items (Reset Items)

This is the same as resetting the display items in the 4-, 8-, and 16-value displays.

▶ Click here.

Columns (Column Settings)

Number of Columns (Column Num)

You can set the number of columns to 4 or 6.

Column Number (Column No.)

Select the number of the column that you want to configure.

Element (Element/Σ)

- You can select the element/wiring unit from the options below. The available options vary depending on the installed elements.
  None, Element1, Element2, Element3, Element4, Element5, Element6, ΣA, ΣB, and ΣC
- If you select None, no measurement data is displayed in the selected column.
- If the selected wiring unit does not have any elements assigned to it, because there is no data, "-------" (no data) is displayed. For example, if elements are assigned to ΣA but not to ΣB, the measurement function for ΣB is displayed as "-------" (no data).

Directly Selecting Elements (ELEMENT)

This is the same as direct element selection in the 4-, 8-, and 16-value displays.

▶ Click here.

Resetting the Settings (Reset Items Exec)

Reset the column settings.

Turning the Display Frame On and Off (Display Frame)

This is the same as turning the display frame on and off in the 4-, 8-, and 16-value displays.

▶ Click here.

All Items Display (All Items)

You cannot change individual measurement functions. Change the display by pressing PAGE UP and PAGE DOWN or the up and down cursor keys.

The number of displayed pages varies as indicated below depending on the installed options.

		Harmonic Measurement Option or Simultaneous Dual Harmonic Measurement Option	
		Installed	Not installed
Delta computation option	Installed	12 pages	8 pages
	Not installed	12 pages	7 pages

Order (Order (k); option)

This setting is valid on the 9th or 10th page. On the 9th or 10th page, the order setting appears in the upper left of the screen. This is the same as setting the order in the 4-, 8-, and 16-value displays.

▶ Click here.

Turning the Display of the Numeric Data for All Elements and Wiring Units On and Off (Display All Elements)

- OFF
  The numeric data is displayed in six columns. If there is a total of seven or more elements and wiring units, you can change the displayed elements and wiring units by pressing the left and right cursor keys.
- ON
  When there is a total of 7 or more elements and wiring units, all the numeric data for the elements and wiring units is displayed in nine columns. If you select ON when the total number of elements and wiring units is six or less, the display is the same as when OFF is selected.

Turning the Display Frame On and Off (Display Frame)

This is the same as turning the display frame on and off in the 4-, 8-, and 16-value displays.

▶ Click here.

Single Harmonics and Dual Harmonics Lists (Hrm List Single/ Dual; option)

For each measurement function, you can display the numeric data for a harmonic order from 0 (DC) to 500 or for all harmonic orders in two columns.
This item is available on models with the harmonic measurement option or the simultaneous dual harmonic measurement option.

Item Number to Set (List Item No.)

- You can specify two lists to show in the harmonic order data display area (the right side of the screen). Select the number—1 or 2—of the list that you want to select.
  - When Hrm List Single is selected, the data of List Item No1 is listed in two columns.
  - When Hrm List Dual is selected, the data of List Item No1 is listed in one column, and the data of List ItemNo2 is listed in another column.
- You cannot change individual items in the measurement function display area (the left side of the screen). Change the display by pressing PAGE UP and PAGE DOWN or the up and down cursor keys.

Function (Function)

Select the measurement function to show in the harmonic order data display area from the following options.
U, I, P, S, Q, λ, Φ, ΦU, ΦI, Z, Rs, Xs, Rp, and Xp

Direct Function Selection (U/I/P, S/Q/λ/Φ, WP/q/TIME, FU/FI/η, and U/I MODE)

Directly select the measurement function to show in the harmonic order data display area. This is the same as direct function selection in the 4-, 8-, and 16-value displays.
However, when you are displaying the single harmonics or dual harmonics list, you can only select measurement functions that have harmonic order data. You can press U/I/P to select U, I, or P. You can press S/Q/λ/Φ to select S, Q, λ, Φ, ΦU, or ΦI. WP/q/TIME, FU/FI/η, and U/I MODE are invalid.

Element (Element/Σ)

You can select the element or wiring unit to display in the harmonic order data display area. This is the same as setting the element in the 4-, 8-, and 16-value displays.
▶ **Click here.**

Directly Selecting Elements (ELEMENT)

You can select the element or wiring unit to display in the harmonic order data display area. This is the same as direct element selection in the 4-, 8-, and 16-value displays.
▶ **Click here.**

Order

The Total value and 0 (DC) order numeric data is always displayed at the top of the harmonic order data display area. To switch between the displays of the numeric data for harmonic orders 1 to 500, press PAGE UP and PAGE DOWN or use the up and down cursor keys.
The number of harmonic orders that switch when you change the page is indicated below.

	Normal display (1 screen)	Split display
Hrm List Single	40 orders	20 orders
Hrm List Dual	20 orders	10 orders

Turning the Display Frame On and Off (Display Frame)

This is the same as turning the display frame on and off in the 4-, 8-, and 16-value displays.
▶ **Click here.**

Custom Display (Custom)

Loading a Display Configuration File (Load Items)

On the file list, specify a file to load display configuration data from. The extension is .TXT.
For information about how to configure the file list display and how to operate files and folders, see “File Operations (Utility).”

▶ Click here.

Loading a Background File (Load Bmp)

On the file list, specify a background file to load. The extension is .BMP.
If you use a commercial graphics program to create an image that meets the following specifications, you can load the image to the WT1800.

- File format: BMP
- Resolution: 800 × 672 pixels
- Color scale: 16-bit high color (R: 5 bits, G: 6 bits, B: 5 bits) or 24-bit true color (R: 8 bits, G: 8 bits, B: 8 bits)
- Size: Approx. 1 MB (16 bit) or approx. 1.6 MB (24 bit)

▶ Click here.

- If you attempt to load an image that does not meet the above specifications, the image will not be displayed properly, or an error message will appear and you will not be able to load the image.
- After you properly load a display configuration file and a background file, if you restart the WT1800 and the same background file is not in the same location, the background will return to its default.

Simultaneously Loading a Display Configuration File and a Background File (Load Items & Bmp)

When you select a display configuration file (.TXT) from the file list and load it, if there is a background file with a .BMP extension and the same name as the display configuration file, that file is also loaded.

▶ Click here.

If there is no background file with the same name as the display configuration file in the same directory as the display configuration file, an error occurs.

Display Configuration (Edit Items)

Total Number of Items (Total Items)

You can set the total number of numeric data boxes to display to a number from 1 to 192.*

Number of Items per Page (Items Per Page)

You can set the total number of numeric data boxes to display per page to a number from 1 to 192.*
The total number of pages is Total Items/Items Per Page.

* The ranges of Total Items and Items Per Page are related as indicated below.

- Total Items: Items Per Page to Items Per Page × 12
- Items Per Page: Total Items/12 to Total Items

Customizing the Displayed Items (Custom Items)

- **Item Number to Set (Item No.)**
  Select the number of the item that you want to configure.
- **Function (Function)**
  This is the same as setting the function in the 4-, 8-, and 16-value displays.
  ▶ Click here.
  If you select None, you can display a character string in the numeric data box. Select the String menu item to enter the string.
- **Element (Element/Σ)**
  This setting is valid when Function is not set to None. This is the same as setting the element in the 4-, 8-, and 16-value displays.
  ▶ Click here.
- **Order (Order; option)**
  This is the same as setting the order in the 4-, 8-, and 16-value displays.
  ▶ Click here.
  If you set Function to None, instead of the Order menu item, a menu item for entering a string (String) appears.
- **String (String)**
  This menu item appears when you set Function to None. Enter the character string to display in the numeric data box. You can enter a string of up to 15 characters in length.
  If you do not set Function to None, instead of the String menu item, the Order menu item appears.
- **X Display Position (X Pos)**
  Set the position where the left edge of the numeric data box will appear on the screen to a value from 0 (the left edge of the screen) to 800 (the right edge of the screen).
- **Y Display Position (Y Pos)**
  Set the position where the top edge of the numeric data box will appear on the screen to a value from 0 (the top of the screen) to 671 (the bottom of the screen).
- **Font Size (Font Size)**
  Select the font size from the options below.
  14, 16, 20, 24, 32, 48, 64, 96, and 128
- **Font Color (Font Color)**
  Select the font color from the options below.
  Yellow, Green, Magenta, Cyan, Red, Orange, Light Blue, Purple, Blue, Pink, Light Green, Dark Blue, Blue Green, Salmon Pink, Mid Green, Gray, White, Dark Gray, Blue Gray, and Black

Saving the Display Configuration (Save Custom Items)

You can save the display configuration that you have created to the specified storage medium. The extension is .TXT.

- **Displaying a File List and Specifying the Save Destination (File List)**

  On the file list, specify the save destination. For information about how to configure the file list display and how to operate files and folders, see “File Operations (Utility).”

  ▶ **Click here.**

- **Automatic File Naming (Auto Naming)**

  This is the same as the auto naming feature for saving and loading data.

  ▶ **Click here.**

- **File Name (File Name)**

  This is the same as file name setting for saving and loading data.

  ▶ **Click here.**

- **Saving (Save Exec)**

  Saves the display configuration.

- Note that if there is a file with the same name in the save destination, it will be overwritten without warning.
- File names are not case sensitive.

Turning the Display Frame On and Off (Display Frame)

This is the same as turning the display frame on and off in the 4-, 8-, and 16-value displays.

▶ **Click here.**

8 Computation

Computation (MEASURE)

You can set the following items.

- User-defined functions (User Defined Function)
- Measuring the Average Active Power
- MAX hold (Max Hold)
- User-defined events (User Defined Event)
- Apparent power, reactive power, and corrected power equations (Formula)
- Sampling frequency (Sampling Frequency)
- Phase difference display format (Phase)
- Master/slave synchronization measurement (Sync Measure)
- Voltages or currents whose frequencies will be measured (FREQ MEASURE)

User-Defined Functions (User Defined Function)

You can combine function symbols to create equations and use the numeric data of the combined functions to determine the value of the equation. It is convenient to use a USB keyboard when entering multiple equations or particularly long equations.

User-defined functions allow you to determine physical values other than those of the measurement functions by combining operands. The measurement functions that you can specify for the efficiency equation are fixed at power and motor output. However, by using user-defined functions, you can create equations consisting of measurement functions other than power and motor output measurement functions to determine ratios other than efficiency.

Selecting Which User-Defined Function to Configure

Select the number of the user-defined function that you want to configure from the options below.

- User Defined F01 to F05: User-defined functions F1 to F5
- User Defined F06 to F10: User-defined functions F6 to F10
- User Defined F11 to F15: User-defined functions F11 to F15
- User Defined F16 to F20: User-defined functions F16 to F20

Turning the Computation of a User-Defined Function On or Off

Selecting Whether to Compute a User-Defined Function

User-Defined Function Name (Name)

- Number of characters: Up to eight
- Usable characters: Spaces and all characters that are displayed on the keyboard

Unit (Unit)

- Number of characters: Up to eight
- Usable characters: Spaces and all characters that are displayed on the keyboard

Expression (Expression)

Operation Type

You can use combinations of measurement functions and element numbers (e.g., Urms1) as operands to configure up to 20 equations (F1 to F20). There can be up to 16 operands in 1 equation.
The different types of operands are listed below (measurement function: operand).

- **Normal Measurement**

  Voltage, current, and power

Urms: URMS( )	Irms: IRMS( )	P: P( )
Umn: UMN( )	Imn: IMN( )	S: S( )
Udc: UDC( )	Idc: IDC( )	Q: Q( )
Urmn: URMN( )	Irmn: IRMN( )	λ: LAMBDA( )
Uac: UAC( )	Iac: IAC( )	Φ: PHI( )
U+pk: UPPK( )	I+pk: IPPK( )	Pc: PC( )
U–pk: UMPK( )	I–pk: IMPK( )	P+pk: PPPK( )
CfU: CFU( )	CfI: CFI( )	P–pk: PMPK( )
fU: FU( )	fI: FI( )	——

  Integrated power

Wp: WH( )	q: AH( )	Time: TI( )
Wp+: WHP( )	q+: AHP( )	WS: SH( )
Wp–: WHM( )	q–: AHM( )	WQ: QH( )

  Efficiency

  η1: ETA1( ) to η4: ETA4( )

  User-defined functions

  F1: F1( ) to F20: F20( )

  User-defined events

  Ev1: EV1( ) to Ev8: EV8( )

- **Harmonic Measurement (Option)**

U(k): UK(,)	I(k): IK(,)	P(k): PK(,)
S(k): SK(,)	Q(k): QK(,)	λ(k): LAMBDAK(,)
ΦU(k): UPHI(,)	ΦI(k): IPHI(,)	Φ(k): PHIK(,)
Z(k): ZK(,)	Rs(k): RSK(,)	Xs(k): XSK(,)
——	Rp(k): RPK(,)	Xp(k): XPK(,)
Uhdf(k): UHDF(,)	Ihdf(k): IHDF(,)	Phdf(k): PHDF(,)
Uthd: UTHD( )	Ithd: ITHD( )	Pthd: PTHD( )
Uthf: UTHF( )	Ithf: ITHF( )	——
Utif: UTIF( )	Itif: ITIF( )	——
hvf: HVF( )	hcf: HCF( )	——
fPLL1: PLLFRQ1( )	fPLL2: PLLFRQ2( )	Kfactor: KFACT( )
ΦU1–U2: PHIU1U2( )	ΦU1–U3: PHIU1U3( )	ΦU1–I1: PHIU1I1( )
ΦU2–I2: PHIU2I2( )	ΦU3–I3: PHIU3I3( )	——

- **Delta Computation (Option)**

ΔU1( ): DELTAU1( )	ΔI( ): DELTAI( )	ΔP1( ): DELTAP1( )
ΔU2( ): DELTAU2( )	——	ΔP2( ): DELTAP2( )
ΔU3( ): DELTAU3( )	——	ΔP3( ): DELTAP3( )
ΔUΣ( ): DELTAUSIG( )	——	ΔPΣ( ): DELTAPSIG( )
ΔU1rms( ): DELTAU1RMS( )	ΔU1mean( ): DELTAU1MN( )	ΔU1rmean( ): DELTAU1RMN( )
ΔU2rms( ): DELTAU2RMS( )	ΔU2mean( ): DELTAU2MN( )	ΔU2rmean( ): DELTAU2RMN( )
ΔU3rms( ): DELTAU3RMS( )	ΔU3mean( ): DELTAU3MN( )	ΔU3rmean( ): DELTAU3RMN( )
ΔUΣrms( ): DELTAUSIGRMS( )	ΔUΣmean( ): DELTAUSIGMN( )	ΔUΣrmean( ): DELTAUSIGRMN( )
ΔU1dc( ): DELTAU1DC( )	ΔU1ac( ): DELTAU1AC( )	ΔIrms( ): DELTALRMS( )
ΔU2dc( ): DELTAU2DC( )	ΔU2ac( ): DELTAU2AC( )	ΔImean( ): DELTAIMN( )
ΔU3dc( ): DELTAU3DC( )	ΔU3ac( ): DELTAU3AC( )	ΔIrmean( ): DELTAIRMN( )
ΔUΣdc( ): DELTAUSIGDC( )	ΔUΣac( ): DELTAUSIGAC( )	ΔIdc( ): DELTAIDC( )
——	——	ΔIac( ): DELTAIAC( )

- **Motor Evaluation (Option)**

Speed: SPEED( )	Torque: TORQUE( )	Pm: PM( )
Slip: SLIP( )	SyncSp: SYNC( )	EaU: EAU( )
EaI: EAI( )	——	——

- **Auxiliary Input (Option)**

Aux1: AUX1( )	Aux2: AUX2( )

Setting Operand Parameters

The parameters that you need to enter depend on whether the function is followed by “(,)” or “( )”.

- **Setting Parameters for Functions Followed by “(,)”**

  Specify the element to the left of the comma, and specify the harmonic order to the right of the comma. For example: (E1,OR2).
  - Symbols used to represent elements

    E1 to E6: Elements 1 to 6

    E7 to E9: Wiring units ΣA to ΣC
  - Symbols that indicate the harmonic order (Order)*

    ORT: Total value

    OR0: dc

    OR1: Fundamental wave

    OR2 to OR500: Harmonic orders 2 to 500

    * On models with the harmonic measurement option or the simultaneous dual harmonic measurement option.

- **Setting Parameters for Functions Followed by “( )”**

  Specify the element. You do not need to specify a harmonic order. For example: (E1).

For information about the parameters that you can use with each operand, see appendix 6 in the getting started guide, IM WT1801-03EN.

Values Substituted in Operands

- The unit of TI values is seconds.
- η1 to η4 are displayed as percentages (see in appendix 1 in the getting started guide, IM WT1801-03EN). However, in this section ETA1 to ETA4 are described as ratios.
  Example When η1 is 80%, ETA1 is 0.8
- The U1 in PHIU1U2 represents the voltage signal of the element whose element number is the smallest in the wiring unit (ΣA, ΣB, or ΣC). For example, if input elements 2, 3, and 4 are assigned to wiring unit ΣA, PHIU1U2 is the phase difference between the voltage signals of input elements 2 and 3.
- User-defined equations can use other user-defined equations with smaller numbers as operands. For example, the equation for user-defined function F3 can be set to F1( ) + F2( ). This allows equations that would otherwise exceed 50 characters in length to be computed. This can be accomplished by for example setting equations in F1 and F2, and then adding or dividing those equations in F3. This feature is also convenient when defining multiple equations that include common operands. For example, you can set common operands in F1, and then set F4 as F3( ) divided by F1( ) and set F5 as F4( ) divided by F1( ). However, if you enter a user-defined equation with a number that is greater than or equal to its own number, correct results will not be obtained. For example, if you set user-defined function F3 to F1( )+F3( ) or to F1( )+F4( ), the computed result will be displayed as "-------" (no data) or "-OF-" (overflow).

Operators

The following operators can be used in equations.

Operator	Example	Description
+, –, *, /	U(E1,OR1)–U(E2,OR1)	Basic arithmetic
ABS	ABS(P(E1,ORT) + P(E2,ORT))	Absolute value
SQR	SQR(I(E1,OR0))	Square
SQRT	SQRT(ABS(I(E1,OR3)))	Square root
LOG	LOG(U(E1,OR25))	Natural logarithm
LOG10	LOG10(U(E1,OR25))	Common logarithm
EXP	EXP(U(E1,OR12))	Exponent
NEG	NEG(U(E1,OR12))	Negation

Number and Type of Characters That Can Be Used in Equations

- Number of characters: Up to 50
- Usable characters: Spaces and all characters that are displayed on the keyboard
  On the keyboard, press [SHIFT] to enter operand and equation characters. The characters that you can select are indicated below.

ABS(	PPK(	HVF(	RMS(
SQR(	MPK(	HCF(	MN(
SQRT(	CF	KFACT(	RMN(
LOG(	TI(	EAU(	DC(
LOG10(	THD(	EAI(	AC(
EXP(	THF(	PLLFRQ(	PC(
NEG(	TIF(	——	——

Equation Examples

An equation to determine the rms value of the harmonic components of the voltage signal of input element 2.

$$\sqrt{(\text{Total rms voltage value})^2 - (\text{Rms value of the fundamental voltage signal})^2}$$

SQRT(SQR(U(E2,ORT))–SQR(U(E2,OR1)))

If an operand in an equation is undetermined, the computed result is displayed as "-------" (no data). This occurs when a delta computation measurement function is in the equation, but delta computation is turned OFF, or when a measurement function of an element that is not installed is in the equation.

Measuring the Average Active Power

The average active power can be computed for devices, such as intermittent control devices, whose power fluctuates. Use a user-defined function to specify the equation for computing the average active power.

$$\text{Average active power} = \frac{\text{Integrated power}}{\text{Elapsed integration time}}$$

Use the equation above. For example, to determine the average active power of element 1, set the equation of a user-defined function as follows:

WH(E1)/(TI(E1)/3600)

The unit of TI values is seconds.

MAX Hold (Max Hold)

Selecting Whether to Hold the Maximum Numeric Value (MAX value) You can determine the measurement functions whose maximum values will be held using a user-defined function. The different types of operands are listed below (measurement function: operand).

Urms: URMSMAX( )	Irms: IRMSMAX( )	P: PMAX( )
Umn: UMEANMAX( )	Imn: IMEANMAX( )	S: SMAX( )
Udc: UDCMAX( )	Idc: IDCMAX( )	Q: QMAX( )
Urmn: URMEANMAX( )	Irmn: IRMEANMAX( )	——
Uac: UACMAX( )	Iac: IACMAX( )	——
U+pk: UPPEAKMAX( )	I+pk: IPPEAKMAX( )	P+pk: PPPEAKMAX( )
U–pk: UMPEAKMAX( )	I–pk: IMPEAKMAX( )	P–pk: PMPEAKMAX( )

To hold the maximum value of the Urms for element 1, enter URMSMAX(E1) in the equation for a user-defined function, and enable MAX hold.

- For information about the parameters that you can use with each operand, see appendix 6 in the getting started guide, IM WT1801-03EN.
- The maximum values of the data above are held while the MAX hold function is enabled.
- The D/A output values, the values in the data lists printed by the built-in printer, and the communication values all reflect the held maximum values.

- When MAX hold is applied to measurement functions that have positive and negative values, the WT1800 compares the absolute values to determine the maximum value.
- To reset held maximum values, turn MAX hold off, and then turn it on again.

User-Defined Events (User Defined Event)

User-defined events can be used to trigger data storage and automatic printing (option). You can define up to eight user-defined events.

User-Defined Event Number (Event No.)

Select a user-defined event number from 1 to 8.

Turning User-Defined Events On and Off

Select whether to enable user-defined events.

User-Defined Event Name (Event Name)

- Number of characters: Up to eight
- Usable characters: Spaces and all characters that are displayed on the keyboard

Indication of User-Defined Event Occurrence (TRUE/FALSE)

Set the character strings to show when a user-defined event occurs and when it does not occur.

- Number of characters: Up to six
- Usable characters: Spaces and all characters that are displayed on the keyboard

Judgment Condition Specification Method (Expression)

Select the method for specifying judgment conditions from the following options.

- Range (Range): Specify judgment conditions using ranges of measurement function values or differences from a reference value.
- Condition (Condition): Specify judgment conditions using user-defined events.

Range (Range)

Specify the judgment condition here when you have set the judgment condition specification method to Range.

- **Function (Function)**

  You can select any of the measurement function types listed under “Items That This Instrument Can Measure.”

  ▶ **Click here.**

- **Element (Element/Σ)**

  You can select the element/wiring unit from the options below. The available options vary depending on the installed elements.

  Element1, Element2, Element3, Element4, Element5, Element6, ΣA, ΣB, and ΣC

- **Order (Order; option)**

  This is the same as setting the harmonic order in the 4-, 8-, and 16-value displays.

  ▶ **Click here.**

- **Judgment Condition**

  Select the method for comparing the measured value and the reference value from the following options.

  OFF, <, <=, =, >, >=, != (not equal)

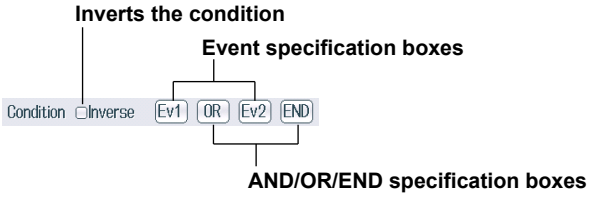
- **Reference Value**

  Select a number from –9.9999 T to 9.9999 T.

For example, a condition that is true when 150 < the measured power value of element 1 < 160 W and false otherwise would be configured as shown below.

Condition (Condition)

Specify the judgment condition here when you have set the judgment condition specification method to Condition.



Inverting the Condition (Inverse)

You can invert the judgment of the condition indicated to the right of the check box.

Event Specification Boxes

You can select the number of a user-defined event that is smaller than the number of the user-defined event that you are currently configuring. For example, when you are configuring the conditions of user-defined event Ev3, you can select Ev1 or Ev2.

AND/OR/END Specification Boxes

- **AND and OR**

  To use multiple user-defined events to configure a condition, set the method of combining the events to logical AND or logical OR. When you select AND or OR, an event specification box appears to the right of the AND/OR/END specification box. The number of user-defined events that you can combine is indicated below. When you reach the maximum number of combinable user-defined events, no AND/OR/END specification box appears to the right of the last event.
  - Ev1: 0. You cannot use other user-defined events as conditions. Set the judgment condition using a range.
  - Ev2: 1 (Ev1)
  - Ev3: 2 (Ev1 and Ev2)
  - Ev4: 3 (Ev1 to Ev3)
  - Ev5: 4 (Ev1 to Ev4)
  - Ev6: 5 (Ev1 to Ev5)
  - Ev7: 6 (Ev1 to Ev6)
  - Ev8: 7 (Ev1 to Ev7)
- **END**

  Select END to end the definition of the condition. No event specification box appears to the right of an AND/OR/END specification box that has been set to END.

If you set the event judgment condition to a range and the function of the judgment condition returns a value of “-------” (no data), because judgment cannot be performed, the judgment result is FALSE. For example, when integration is not being performed, if the function of event Ev1 is set to integrated power (WP) and the judgment condition is WH(E1)>0, the measured data is displayed as “-------” (no data), so the judgment for Ev1 is FALSE. Also, if you set the judgment condition specification method to Condition and events that cannot be judged are included in the judgment conditions, the judgment result is FALSE. For example, if you set the judgment condition of event Ev2 to NOT(EV1()), if the judgment for Ev1 is FALSE because of the reason given in the example above, the result for Ev2 is not TRUE but FALSE.

Apparent Power, Reactive Power, and Corrected Power Equations (Formula)

Equation for Apparent Power (S Formula)

You can select the voltage and current to use to compute the apparent power (voltage × current) from the following options.

- Urms*Irms
  The product of the true rms values of the voltage and current
- Umean*Imean
  The product of the voltage's and current's rectified mean values calibrated to the rms values
- Udc*Idc
  The product of the simple averages of the voltage and current
- Umean*Irms
  The product of the voltage's rectified mean value calibrated to the rms value and the current's true rms value
- Urmean*Irmean
  The product of the voltage's and current's rectified mean values

Apparent Power and Reactive Power Computation Types (S,Q Formula)

There are three types of power: active power, reactive power, and apparent power. In general, they are defined by the following equations.

Active power $P = UI\cos\Phi$ (1)

Reactive power $Q = UI\sin\Phi$ (2)

Apparent power $S = UI$ (3)

U = rms voltage; I = rms current; Φ = Phase difference between voltage and current

The power values are related as follows:

$(\text{Apparent power } S)^2 = (\text{Active power } P)^2 + (\text{Reactive power } S)^2$ (4)

The three-phase power is the sum of the power of each phase.

These definitions only apply for sine waves. The measured values for apparent power and reactive power vary for distorted waveform measurement depending on which of the above definitions are combined for the computation. Because the equations for deriving the apparent and reactive power for distorted waveforms are not defined, none of the equations can be said to be more correct than the other. Therefore, the WT1800 provides three equations, Type 1 to Type 3, for determining the apparent power and reactive power.
Unlike apparent power and reactive power, active power is derived directly from the sampled data, so errors resulting from different definitions do not occur.

Type 1 (The method used in the normal mode of conventional WT series power meters)

The WT1800 calculates the apparent power of each phase using equation 3, calculates the reactive power of each phase using equation 2, and sums the results to derive the power.

Active power for a three-phase, four-wire system $P\Sigma = P1 + P2 + P3$

Apparent power for a three-phase, four-wire system $S\Sigma = S1 + S2 + S3$ ($= U1 \times I1 + U2 \times I2 + U3 \times I3$)

Reactive power for a three-phase, four-wire system $Q\Sigma = Q1 + Q2 + Q3$

$$(=s1\times\sqrt{(U1\times I1)^2-P1^2}+s2\times\sqrt{(U2\times I2)^2-P2^2}+s3\times\sqrt{(U3\times I3)^2-P3^2}\ )$$

The signs for s1, s2, and s3 are negative when the current leads the voltage and positive when the current lags the voltage.

Type 2

The WT1800 calculates the apparent power of each phase using equation 3 and sums the results to derive the three-phase apparent power. The WT1800 calculates the three-phase reactive power from the three-phase apparent power and the three-phase active power using equation 4.

Active power for a three-phase, four-wire system $P\Sigma = P1 + P2 + P3$

Apparent power for a three-phase, four-wire system $S\Sigma = S1 + S2 + S3$ ($= U1 \times I1 + U2 \times I2 + U3 \times I3$)

Reactive power for a three-phase, four-wire system $Q\Sigma = \sqrt{S\Sigma^2-P\Sigma^2}$

Type 3 (The method used in the harmonic measurement modes of the WT1600, WT3000 and PZ4000)

The WT1800 calculates the reactive power of each phase using equation 2 and calculates the three-phase apparent power using equation 4. This equation is available on models with the harmonic measurement option or the simultaneous dual harmonic measurement option.

Active power for a three-phase, four-wire system $P\Sigma = P1 + P2 + P3$

Apparent power for a three-phase, four-wire system $S\Sigma = \sqrt{P\Sigma^2 + Q\Sigma^2}$

Reactive power for a three-phase, four-wire system $Q\Sigma = Q1 + Q2 + Q3$

Corrected Power Equation (Pc Formula)

Some standards require that a voltage transformer's active power be corrected when the load connected to the voltage transformer is very small. You can select an equation to use for this correction and specify the coefficient.

Applicable Standard (Select standard)

Select from the following.

- IEC76–1 (1976)
- IEC76–1 (1993)

Equations for each applicable standard

IEC76-1(1976)

$$Pc = \frac{P}{P_1 + P_2 \left(\frac{Urms}{Umn}\right)^2}$$

IEC76-1(1993)

$$Pc = P\left(1 + \frac{Umn - Urms}{Umn}\right)$$

Pc: Corrected power
P: Active power
Urms: True rms voltage
Umn: Voltage's rectified mean calibrated to the rms value
P1, P2: Coefficients specified by the applicable standard

Coefficients (P1 and P2)

You can set coefficients P1 and P2 to values within the range of 0.0001 to 9.9999.

The IEEE C57.12.90-1993 equation is the same as IEC761(1976).

Sampling Frequency (Sampling Frequency)

The WT1800 offers three types of sampling frequencies, each approximately 2 MHz, to prevent the input waveform from being measured as a DC signal because of aliasing. You can choose to automatically switch the sampling frequency or choose to use a fixed frequency.

- Auto: The WT1800 automatically switches between clocks A, B, and C.
- Clock A: 2.000000 MHz
- Clock B: 1.941176 MHz
- Clock C: 1.885714 MHz

- Set the sampling frequency to Auto to prevent the measured values from being distorted by aliasing.
- If you want to use a fixed sampling frequency, select a frequency from Clock A to Clock C.

Phase Difference Display Format (Phase)

The phase difference Φ between the voltage and current indicates the current phase relative to the voltage of each element. Set the display format to one of the options below.

- **180 degrees**

  If the current phase is in the counterclockwise direction with respect to voltage, the current is leading (D) the voltage. If the current phase is in the clockwise direction with respect to the voltage, the current is lagging (G) the voltage. The phase difference is expressed by an angle between 0 and 180° (see appendix 2 in the getting started guide, IM WT1801-03EN).

- **360 degrees**

  The phase difference is expressed as an angle between 0 and 360° in the clockwise direction.

- If the measured voltage or current value is zero, “Error” is displayed.
- When both the voltage and current signals are sinusoidal waves and the ratios of the voltage and current inputs with respect to the measurement range do not differ greatly, the phase difference Φ lead and lag are still detected and displayed correctly.
- If the computation result of power factor λ exceeds 1, Φ is displayed as follows:
  - If the power factor λ is greater than 1 and less than or equal to 2, Φ returns 0.
  - If λ is greater than 2, Φ returns an error (“Error” is displayed).
- On models with the harmonic measurement option, the phase differences ΦU and ΦI of harmonic orders 1 to 500 of the voltage and current are always displayed using an angle between 0 and 180° (no sign for lead and negative sign for lag).

Master/Slave Synchronization Measurement (Sync Measure)

Connect the external start signal input/output connectors (MEAS. START) of the master and slave instruments using a BNC cable (sold separately). You can synchronize the measurement of two WT1800s making one WT1800 the master and the other WT1800 the slave. The master outputs a measurement start signal, and the slave receives the signal.
For the specifications of the external start signal input/output connectors, see section 4.4 in the getting started guide, IM WT1801-03EN.

The measurement of the master and slave cannot be synchronized under the following conditions:

- When the data update interval differs between the master and slave.
- During real-time integration mode or real-time storage mode.

Follow the procedure below to hold the display during synchronized measurement.

- To hold the display: Hold the display of the master first.
- To unhold the display: Unhold the display of the slave first.

Voltages or Currents Whose Frequencies Will Be Measured (FREQ MEASURE)

Select the three voltages or currents to measure the frequencies of from the options below. The available options vary depending on the installed elements.

U1, I1, U2, I2, U3, I3, U4, I4, U5, I5, U6, and I6

On models with the add-on frequency measurement option, the frequencies of the voltages and currents of all elements can be measured, so there is no need to set which frequencies to measure. Thus, even if you press SHIFT+MEASURE(FREQ MEASURE), the Freq Items menu will not appear.

- If frequency measurements are unstable because of noise, try using the frequency filter.
- The period cannot be detected if the AC amplitude is small. For information about detectable frequency levels, see the conditions listed in “Frequency Measurement” and “Accuracy” in chapter 6 of the getting started guide, IM WT1801-03EN.”
- The measured data for the frequencies of voltages and currents whose frequencies are not measured is displayed as “-------” (no data).

9 Integrated Power (Watt hours)

The WT1800 can integrate the active power (watt hour), the current (ampere hour), the apparent power (volt-ampere hour), and the reactive power (var hour) values.
For a list of the measurement functions related to integrated power (watt hours) and their descriptions, see “Items That This Instrument Can Measure.”

▶ **Click here.**

You can set the following items.

- Enabling or Disabling Independent Integration (Independent Control)
- Independently integrated elements (Element Object)
- Starting, Stopping, and Resetting Integration (Start/Stop/Reset)
- Integration Conditions (Integ Set)

Integration-Related Display Indications

Integration status

Reset

Displayed when the integrated value is reset and integration can be started.

Start

Displayed along with the elapsed integration time when integration has been started.

Stop

Displayed along with the elapsed integration time when integration has been stopped.

- When integration has been stopped forcibly through the pressing of the Stop soft key, “Stop” appears in yellow. You can press Start to resume integration.
- In real-time normal integration mode and real-time continuous integration mode, once the scheduled integration stop time is reached, “Stop” appears in orange. Even if you press Start, integration is not resumed. To start integration, you must first reset it.

Ready

In real-time normal integration mode, when you press Start, before the scheduled integration start time is reached, “Ready” and the scheduled integration start time appear.

Scheduled integration start time

TimeUp

After the specified integration timer time elapses, integration stops automatically, and “TimeUp” and the elapsed integration time appear.

Error

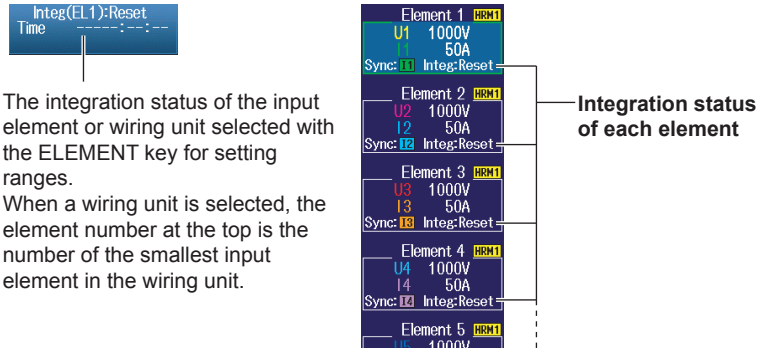
In the following situations, integration stops automatically, and “Error” and the elapsed integration time appear.

- The integration time reaches the maximum integration time (10000 hours).
- The integrated value reaches its maximum or minimum displayable value.
- A power failure occurs when integration is in progress. Even when a power failure occurs, the WT1800 stores and holds the integration result. When the power returns, integration is stopped, and the integration result calculated up to the point when the power failure occurred is displayed.

Example of the Display When the Integration Time Is Set to a Non-Zero Value

Elapsed integration time
Integration timer

Example of the Display When Independent Integration Is Enabled


Integ(EL1):Reset
Time --:--:--
The integration status of the input element or wiring unit selected with the ELEMENT key for setting ranges.
When a wiring unit is selected, the element number at the top is the number of the smallest input element in the wiring unit.
Element 1 HRM1
U1 1000V
I1 50A
Sync: I1 Integ:Reset
Element 2 HRM1
U2 1000V
I2 50A
Sync: I2 Integ:Reset
Element 3 HRM1
U3 1000V
I3 50A
Sync: I3 Integ:Reset
Element 4 HRM1
U4 1000V
I4 50A
Sync: I4 Integ:Reset
Element 5 HRM1
Integration status of each element

Number of Displayed Digits (Display Resolution)

The number of displayed digits (display resolution) for an integrated value is six (the maximum value is 999999). When an integrated value reaches 1000000 counts, the decimal point shifts automatically. For example, if 0.001 mWh is added to 999.999 mWh, the display shows 1.00000 Wh.

Maximum and Minimum Displayable Integrated Values

Active power (WP): ±999999 MWh
Current (q): ±999999 MAh
Apparent power (WS): ±999999 MVAh
Reactive power (WQ): ±999999 Mvarh

Display When Integration Overflow Occurs

If either of the conditions below is met, integration is stopped, and the integration time and integrated value are held.

- The integration time reaches the maximum integration time (10000 hours).
- The integrated value of WP, q, WS, or WQ reaches the maximum or minimum displayable value given above.

Integration When the MAX Hold Feature Is Enabled

The WT1800 determines and displays the integrated value by summing the value that is measured at every data update interval, irrespective of the MAX hold feature.

Integration When the Measured Value Exceeds the Measurement Limit

If a sampled instantaneous current or voltage exceeds the maximum or minimum measurement range limits of the AD circuit, the value is measured as the maximum or minimum measurement range limit value.

Integration When Current Input Is Small

Integration is performed assuming a current of zero when the current input relative to the measurement range is as indicated below.

- When the Crest Factor Is Set to CF3
  When Irms or Iac is 0.5% or less When Imn or Irmn is 2% or less
- When the Crest Factor Is Set to CF6
  When Irms or Iac is 1.0% or less When Imn or Irmn is 4% or less

Sample Rate, and Valid Frequency Ranges for Integration

The sample rate is approximately 2 MHz. The voltage/current signal frequencies that are valid for integration are as follows:

Integrated Item		Valid Frequency Range for Integration
Active power		DC to approximately 1 MHz
Current	When integrating Irms	DC or the lower frequency limit determined by the data update interval to approximately 1 MHz
	When integrating Imn	DC or the lower frequency limit determined by the data update interval to approximately 1 MHz
	When integrating Idc	DC to approximately 1 MHz
	When integrating Irmn	DC or the lower frequency limit determined by the data update interval to approximately 1 MHz
	When integrating Iac	The lower frequency limit determined by the data update interval to approximately 1 MHz

Using an External Signal to Control Integration (Option)

On models with the 20-channel D/A output option, you can use the remote control feature to use an external signal to start, stop, and reset integration. For details about the remote control feature, see appendix 4.6 in the getting started guide, IM WT1801-03EN.

Backup When a Power Failure Occurs

- If a power failure occurs when integration is in progress, the integration result is held. When the power returns, integration is stopped, and the integration result calculated up to the point when the power failure occurred is displayed.
- After the power returns, you must reset integration to start it again.

Limitations on Modifying the Settings during Integration

During integration, there are some settings that you cannot change and functions that you cannot execute. For details, see appendix 9 in the getting started guide, IM WT1801-03EN.

Limitations on Waveform Display during Integration

- During integration, the waveform display trigger does not function. Therefore, the signal level of the waveform display at the left end of the screen may not be stable.
- During integration, the shortest possible waveform data update interval is 1 s. If you select an update interval shorter than 1 s, the numeric data and waveform data will contain measured values for different measurement periods.

Enabling or Disabling Independent Integration (Independent Control)

You can select whether to start, stop, and reset integration on all elements simultaneously or separately.

- OFF: Integration starts, stops, and is reset simultaneously on all elements.
- ON: Integration works differently depending on the independent input element configuration (Element Independent) setting.
  - When independent input element configuration is disabled
    Elements whose wiring system is 1P2W are controlled separately. For elements whose wiring system is not 1P2W, integration starts, stops, and is reset at the same time for all elements in the same wiring unit.
  - When independent input element configuration is enabled
    The integration of each element is controlled separately.

When independent integration and independent input element configuration are enabled and integration is controlled separately for elements in the same wiring unit, because the elements' integration periods differ, the Σ functions for those elements (the functions that deal with wiring unit integration, such as the integrated active power and apparent power functions) return errors.

Independently Integrated Elements (Element Object)

This setting is valid when independent integration is enabled.

- You can select which elements to start, stop, and reset the integration of by selecting the elements' check boxes.
- All ON: All elements are controlled.
- All OFF: No elements are controlled.

Even if you enable independent integration, when independent input element configuration is disabled, the integration of elements in the same wiring unit is controlled simultaneously regardless of whether the elements' check boxes are selected.

Example:

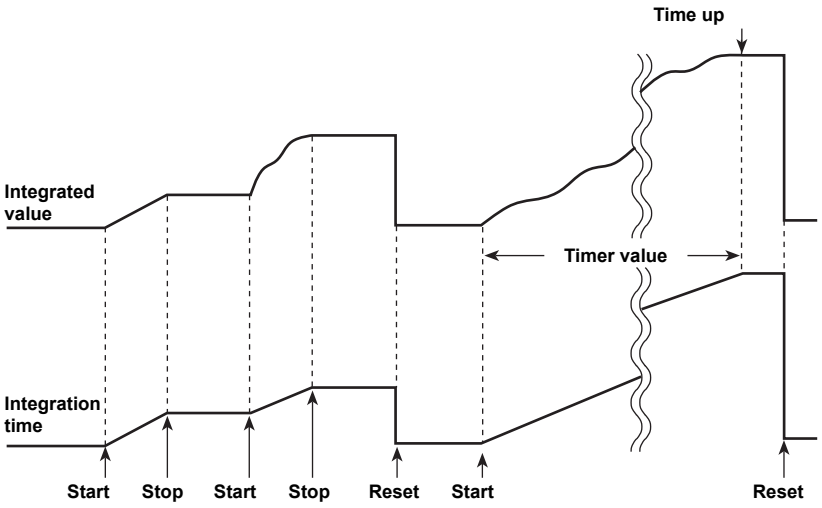
- Elements 1, 2, and 3 are assigned to wiring unit ΣA as a three-phase, four-wire system.
- Under Element Object, the check box of element 1 is selected, but the check boxes of elements 2 and 3 are not.

If you start or stop the integration of element 1 under the above conditions, the integration of elements 2 and 3, whose check boxes are not selected, also starts or stops.

To independently control the integration of input elements that are assigned to the same wiring unit, you must enable independent integration and independent input element configuration.

Starting, Stopping, and Resetting Integration (Start/Stop/Reset)

You can start, stop, and reset integration using the soft keys on the front panel or communication commands. The relationships between integration and starting, stopping, and resetting are indicated below.



Starting Integration (Start)

- Integration starts under the different conditions indicated below depending on the integration mode.
  - Manual integration mode, standard integration mode, and continuous integration mode
    Integration starts immediately.
  - Real-time normal integration mode and real-time continuous integration mode
    The WT1800 enters into an integration-ready state when you press Start. Integration starts when the scheduled start time is reached.
- When integration starts, the START indicator to the right of the INTEG key illuminates, and the integration status indication is “Start.”
- When the WT1800 is in an integration-ready state, the START indicator blinks, and the integration status indication is “Ready.”

When you start integration in auto range mode, the measurement range switches to a fixed range.

Stopping Integration (Stop)

- You can force integration to stop. The integration time and integrated value are held.
- When you force integration to stop, the STOP indicator blinks, and “Stop” appears in yellow as the integration status indication. You can press Start to resume integration. However, after the automatic stopping of integration, which is discussed later, you cannot press Start to resume integration.

Automatic Stopping of Integration

- Integration stops automatically under the different conditions indicated below depending on the integration mode. The integration time and integrated value are held. After integration stops automatically, you cannot resume it by pressing Start. To start integration, you must first reset it.
  - When the integration mode is manual integration mode, standard integration mode, or real-time normal integration mode
    After the specified timer time elapses, integration stops automatically. The STOP indicator illuminates, and the integration status indication is “TimeUp.”
  - When the integration mode is real-time normal integration mode or real-time continuous integration mode
    Integration stops automatically when the scheduled integration end time is reached. The STOP indicator illuminates, and “Stop” appears in orange as the integration status indication.

Resetting Integration (Reset)

The integration time and integrated value are reset. The STOP indicator turns off. The displays for integration-related functions change to "----------" (no data).

When an integration error occurs, the START and STOP indicators blink, and the integration status indication is "Error."

Holding Integration and Releasing the Hold

Holding Integration

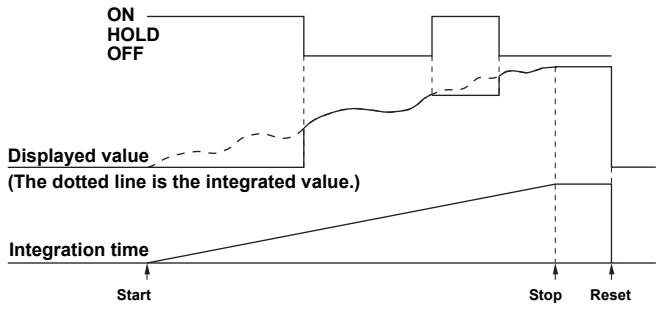
When you press the HOLD key, it illuminates, and the display and communication output of the integration result are held. Integration continues regardless of whether the display is held.

Releasing the Hold on Integration

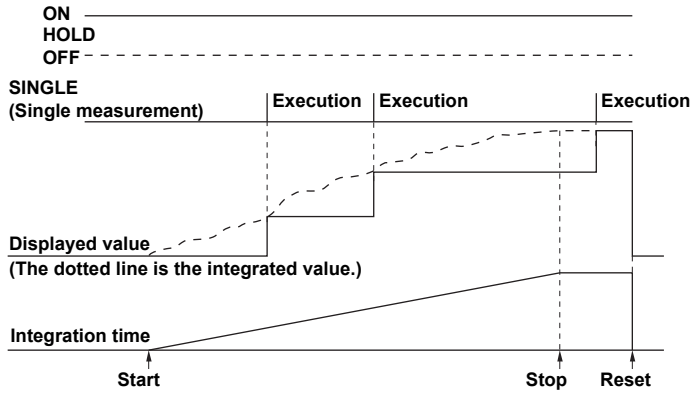
If you press the HOLD key when integration is held, the HOLD key light turns off, and the numeric data display is updated. While the display is held, you can update the display by pressing SINGLE to execute a single measurement.

The relationship between the hold function and the start and stop operations is as follows:

- If you start integration while the display is held, the display and communication output do not change. When you release the hold function (turn it off) or make a single measurement by pressing SINGLE, the integration result at that point is displayed and transmitted.



- If you stop integration while the display is held, the displayed and transmitted values do not change. When you release the hold function (turn it off) or make a single measurement by pressing SINGLE, the integration result at the point when integration was stopped is displayed and transmitted.



Integration Conditions (Integ Set)

You can configure the following integration conditions.

- Integration mode (Mode)
- Integration timer (Integ Timer)
- Scheduled times for real-time integration (Real-time Control)
- Integration auto calibration on/off (Auto Cal)
- Watt hour integration method for each polarity (WP ± Type)
- Current mode for current integration (q Mode)
- Rated time of integrated D/A output (D/A Output Rated Time; option)

Integration Mode (Mode)

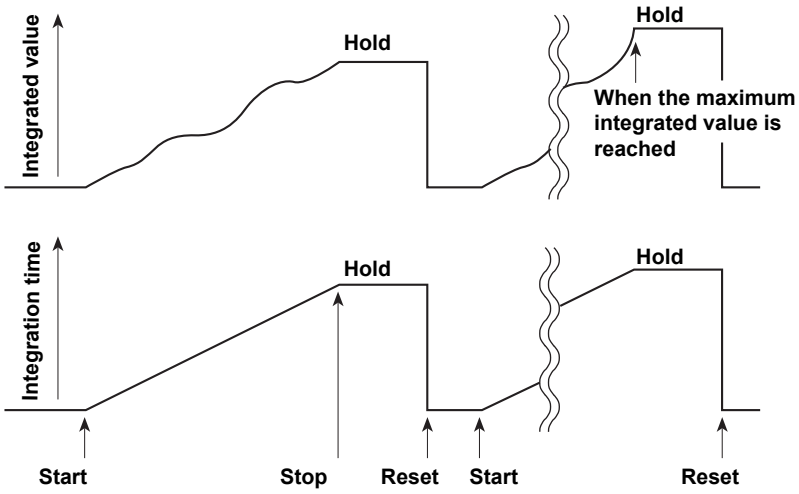
The integration feature has the following five modes.

Integration mode	Start	Stop	Repetition
Manual integration mode (Normal)	Key operation	Key operation	——
Normal integration mode (Normal)	Key operation	Stopped by the timer	——
Continuous integration mode (Continuous)	Key operation	Key operation	Repeats when the timer expires
Real-time normal integration mode (R–Normal)	Date and time	Date and time	——
Real-time continuous integration mode (R–Continuous)	Date and time	Date and time	Repeats when the timer expires

Manual integration mode

When you set the integration mode to normal integration mode (Normal) and set the integration timer to 00000:00:00, the WT1800 performs integration in manual integration mode. After integration is started, it continues until you press Stop. However, if either of the conditions below is met, integration is stopped, and the integration time and integrated value are held.

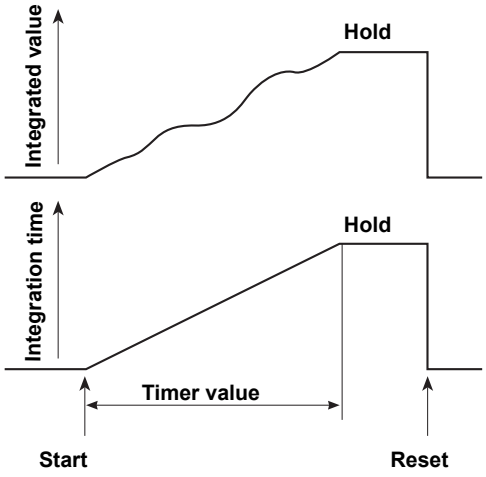
- The integration time reaches the maximum integration time (10000 hours).
- The integrated value reaches its maximum or minimum displayable value.



Normal Integration Mode (Normal)

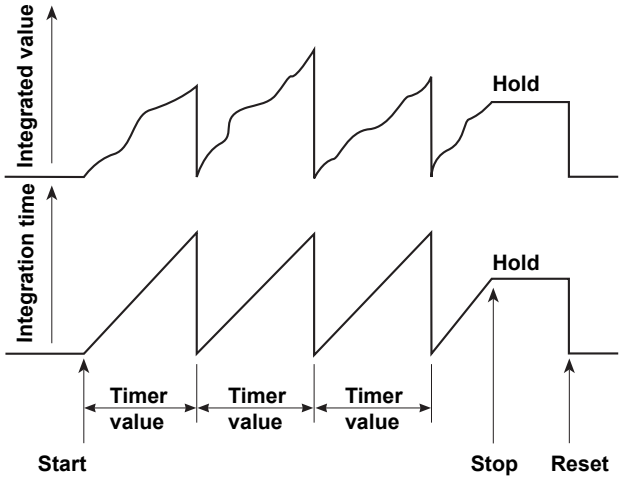
You can set a relative integration time (set a timer). Integration starts when you press Start. When one of the conditions below is met, integration is stopped, and the integration time and integrated value are held.

- The specified timer time elapses.
- The Stop soft key is pressed.
- The integrated value reaches its maximum or minimum displayable value.



Continuous Integration Mode (Continuous integration; Continuous)

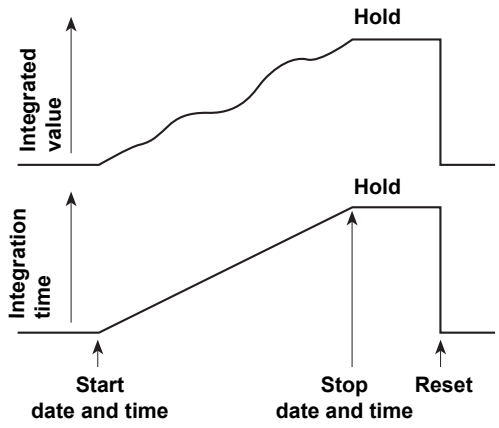
You can set a relative integration time. Integration starts when you press Start. When the specified timer time elapses, integration is automatically reset and restarted. Integration repeats until you press Stop. However, if the integrated value reaches its maximum or minimum displayable value before the specified amount of time has elapsed, integration is stopped, and the integration time and integrated value at that point are held.



Real-Time Normal Integration Mode (R–Normal)

Set the date and time when integration starts and stops and the duration of integration. Integration starts at the scheduled start time. When one of the conditions below is met, integration is stopped, and the integration time and integrated value are held.

- The scheduled stop time is reached.
- The specified timer time elapses.
- The integration time reaches the maximum integration time (10000 hours).
- The integrated value reaches its maximum or minimum displayable value.



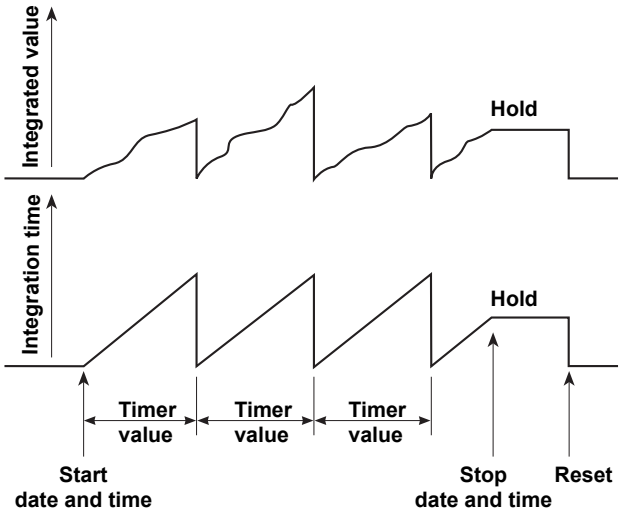
In real-time integration mode, when you set the integration time to 00000:00:00, integration starts at the scheduled start time. When one of the conditions below is met, integration is stopped, and the integration time and integrated value are held.

- The scheduled stop time is reached.
- The integration time reaches the maximum integration time (10000 hours).
- The integrated value reaches its maximum or minimum displayable value.

Real-Time Continuous Integration Mode (Continuous integration; R-Continuous)

Set the date and time when integration starts and stops and the duration of integration. Integration starts at the scheduled start time. When the specified timer time elapses, integration is automatically reset and restarted. If either of the conditions below is met, integration is stopped, and the integration time and integrated value are held.

- The scheduled stop time is reached.
- The integrated value reaches its maximum or minimum displayable value.



Integration Timer (Integ Timer)

You can set the hour, minute, and second within the following range.
00000:00:00 to 10000:00:00

When Independent Integration Is Disabled

The integration timer that you specified above applies to every element.

When Independent Integration Is Enabled

- **Setting**

  You can select the method for setting the integration timer from the following options.
  - Each: Set it separately for each input element.
  - All: Set it for all installed input elements at the same time.

- **Element1 to Element6**

  You can set the integration timers for each element within the range given above.

Scheduled Times for Real-Time Integration (Real-time Control)

This setting is valid in real-time normal integration mode and real-time continuous integration mode.
You can set the year, month, day, hour, minute, and second of the integration start and stop times. Be sure to set the integration stop time to a time after the integration start time. You can set the values within the following ranges.

- Year: Any four-digit Gregorian calendar value
- Hour:Minute:Second: 00:00:00 to 23:59:59
- Now: The scheduled integration start time is set to the current time.
- Copy: The scheduled integration start time is copied to the scheduled integration stop time.

When Independent Integration Is Disabled

The scheduled times that you specified above apply to every element.

When Independent Integration Is Enabled

- **Setting**

  You can select the method for setting the scheduled times from the following options.
  - Each: Set them separately for each input element.
  - All: Set them for all installed input elements at the same time.

- **Element1 to Element6**

  You can set the scheduled times for each element within the range given above.

- You can set the day for the scheduled start or stop time in February to a value as high as the 31st day. If you do so, an error message will appear when you start integration. Reset the scheduled stop time.
- The WT1800 recognizes leap years when it executes the integration operation.
- In real-time normal integration mode and real-time continuous integration mode, after you press Start and the WT1800 enters into an integration-ready state, the numeric data may not be updated immediately. This is because the numeric data is updated in sync with the WT1800 clock. This ensures that the numeric data is updated at the same time as the scheduled integration start time and that the integration time is accurate.

Integration Auto Calibration On/Off (Auto Cal)

Ordinary zero-level compensation takes place when the measurement range or line filter is changed, but you can also automatically calibrate the zero level during integration.

- ON: Zero-level compensation takes place approximately once every hour during integration.
- OFF: Zero-level compensation does not take place during integration.

When integration auto calibration is on and zero-level compensation is in progress, the power or current value measured immediately before is integrated.

Watt Hour Integration Method for Each Polarity (WP ± Type)

Setting

You can select the method for setting the integration method from the following options.

- Each: Set it separately for each input element.
- All: Set it for all installed input elements at the same time.

Element1 to Element6

Set the integration method to one of the options below.

- Charge/Discharge: Measure DC watt hours (for each sampled data item) by polarity.
- Sold/Bought: Measure AC watt hours (for each sampled data item) by polarity.

For information about the equations used in each method, see appendix 1 in the getting started guide, IM WT1801-03EN.

Current Mode for Current Integration (q Mode)

Setting

You can select the method for setting the current mode from the following options.

- Each: Set it separately for each input element.
- All: Set it for all installed input elements at the same time.

Element1 to Element6

You can select the current mode from the following options. For information about the equations used in each mode, see appendix 1 in the getting started guide, IM WT1801-03EN.

- rms: True rms value
- mean: Rectified mean value calibrated to the rms value
- dc: Simple average
- r-mean: Rectified mean value
- ac: AC component

When the current mode is dc, the polarity (+ or -) is displayed.

Rated Time of Integrated D/A Output (D/A Output Rated Time; Option)

This setting appears on models with the 20-channel D/A output option. When integrated values are output through D/A output, a rating value (the same value as the measurement range) is continuously applied, the integrated value after the specified amount of time has elapsed is taken to be 100%, and the D/A output at that point is 5 V. It is assumed that the change in the D/A output from 0% of the integrated value (0 V) to 100% of the integrated value (5 V) will occur linearly over time, and the D/A output value is determined by the ratio of the actual input level to this assumed straight line.

For information about the relationship between the measured integrated D/A output value and the voltage, see "Relationship between Output Items and the D/A Output Voltage."

▶ **Click here.**

Setting the Rated Time for Integrated D/A Output

- You can set the hour, minute, and second within the following range.
  00000:00:00 to 10000:00:00
- This setting is valid in the following integration modes.
  - Manual integration mode
  - Real-time normal integration mode when the integration timer is set to 00000:00:00
- In the following integration modes, the rated time for integrated D/A output is set to the same time that the timer is set to.
  - Normal integration mode
  - Continuous integration mode
  - Real-time normal integration mode when the integration timer is not set to 00000:00:00
  - Real-time continuous integration mode

When the rated time for integrated D/A output is set to 00000:00:00, the D/A output for the integrated value is fixed at 0 V.

10 Waveform Display

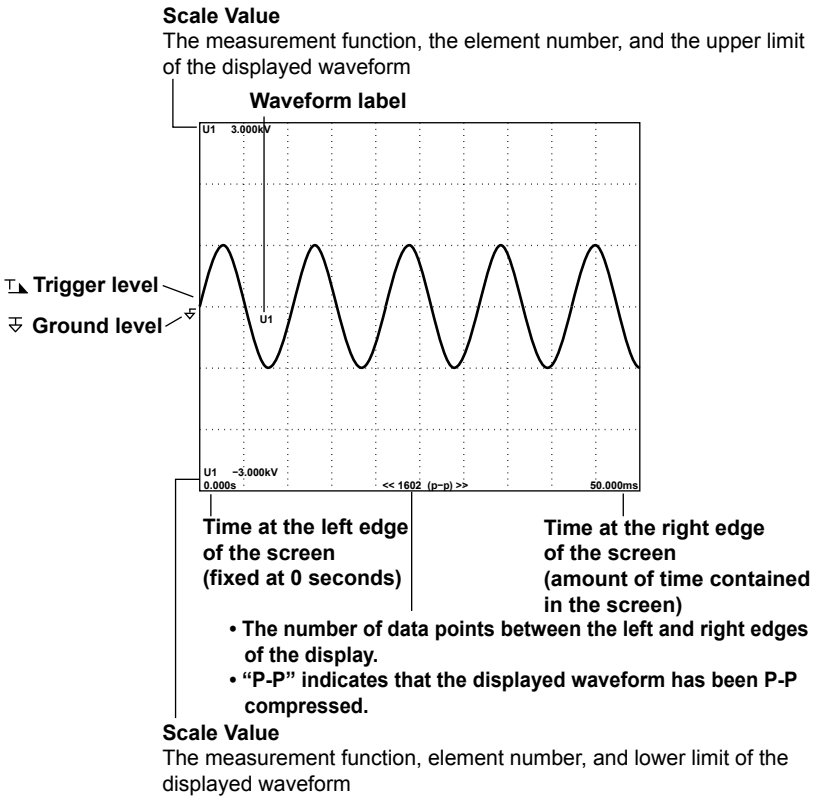
Waveform Display (WAVE)

You can press WAVE to make the waveform displays of the following types of input signals.

- Input element voltage and current
- Motor evaluation function (option) speed and torque
- Auxiliary inputs (option) Aux1 and Aux2

Each time you press WAVE, the number of split screens switches in order between none, 2, 3, 4, and 6.

Waveform Display Example


Scale Value
The measurement function, the element number, and the upper limit of the displayed waveform
Waveform label
U1 3.000kV
Trigger level
Ground level
U1
U1 -3.000kV
0.000s
<< 1602 (p-p) >>
50.000ms
Time at the left edge of the screen (fixed at 0 seconds)
Time at the right edge of the screen (amount of time contained in the screen)
• The number of data points between the left and right edges of the display.
• "P-P" indicates that the displayed waveform has been P-P compressed.
Scale Value
The measurement function, element number, and lower limit of the displayed waveform

Measurement Mode during Waveform Display

When waveforms are displayed, the measurement mode indicated in the upper left of the screen is Normal Mode (Trg). After a trigger occurs, measurement takes place at the data update interval.

- If you do not set the trigger level properly, the waveform display start point (the signal level on the left edge of the screen) may be unstable, or waveforms may not appear.
- Even when waveforms are displayed, in the following situations, the measurement mode indication at the upper left of the screen is Normal Mode.
  - During integration
  - When the trigger mode is OFF

  In Normal Mode, measurements are taken and the sampled data is updated automatically at the data update interval. In this mode, there are limitations on the waveform display feature.

  ▶ **Click here.**

Display Format (FORM)

You can configure the following display format settings.

- Number of windows (Format)
- Time axis (Time/div)
- Trigger (Trigger Settings)
- Advanced waveform display settings (Display Settings)
- Waveform mapping (Wave Mapping)

Number of Windows (Format)

You can divide the screen equally into windows, and assign waveforms to those windows. This function is useful when there are many waveforms and it is difficult to view them all in a single display.

You can choose the number of windows from one of the following options:

- Single: No windows
- Dual: Two windows
- Triad: Three windows
- Quad: Four windows
- Hexa: Six windows

Depending on the number of windows, the number of displayed points in each window changes as described below.

Single: 672 points, Dual: 336 points, Triad: 224 points, Quad: 168 points, Hexa: 112 points

When the screen is split, the number of displayed points along the vertical axis of a single window is halved.

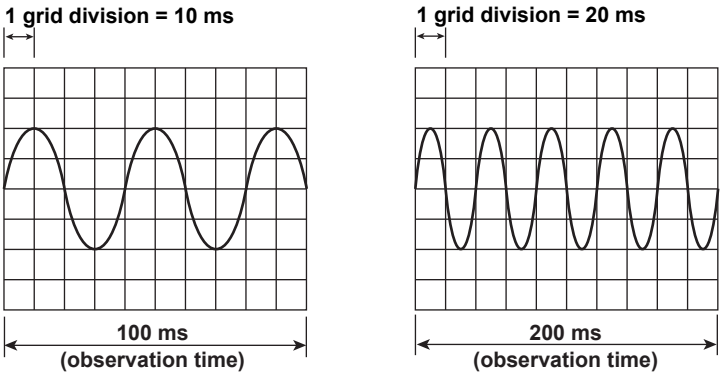
For information about how to assign waveforms to windows, see “Waveform Mapping.”

▶ **Click here.**

Time Axis (Time/div)

The time axis is set in Time/div (time per grid division).

The time axis can be set up to the point in which the time corresponding to one screen is equal to the data update interval, in 1, 2, 5 steps. For example, when the data update interval is 500 ms, if you change the time-per-division in this order: 0.05 ms > 0.1 ms > 0.2 ms > 0.5 ms >1 ms > 2 ms > 5 ms > 10 ms > 20 ms > 50 ms, the time corresponding to one screen changes in this order: 0.5 ms > 1 ms > 2 ms > 5 ms > 10 ms > 20 ms > 50 ms > 100 ms > 200 ms > 500 ms.



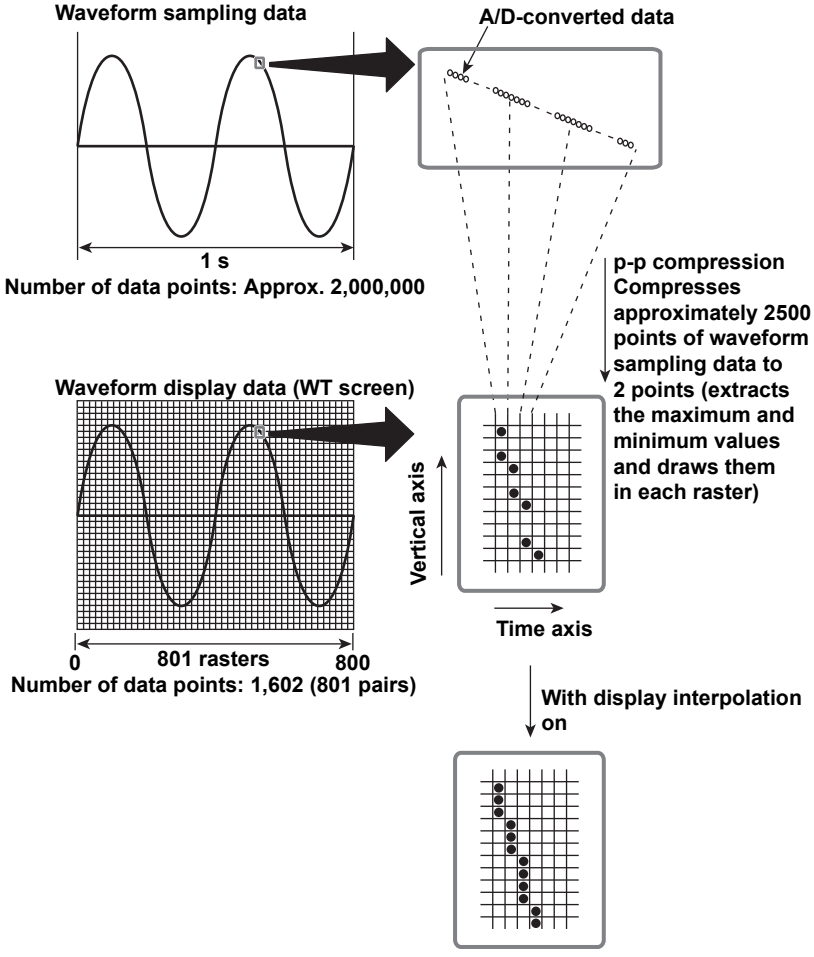
Difference between Waveform Sampling Data and Waveform Display Data

Waveform sampling data and waveform display data are both measured waveform data, but they differ as described below.

- **Waveform sampling data: Data derived through A/D conversion of the input signal**
  The WT1800 A/D conversion rate is approximately 2 MS/s. Therefore, if the data update interval is set to 1 s, the number of data points sampled from a single input signal in a single measurement is approximately 2,000,000 (see the figure below). Waveform sampling data is also called acquisition data or raw wave data.
- **Waveform display data: Waveform data displayed on the WT1800 screen (1602 points)**
  When the WT1800 displays waveforms, data points (of waveform display data) are displayed in horizontal rasters (along the time axis). The number of rasters is 801. Each raster contains two points of waveform display data. The two data points are the maximum and minimum values of the waveform data in each raster. Therefore, the number of waveform display data points (the number of points displayed on the screen) for a single input signal is 1602.

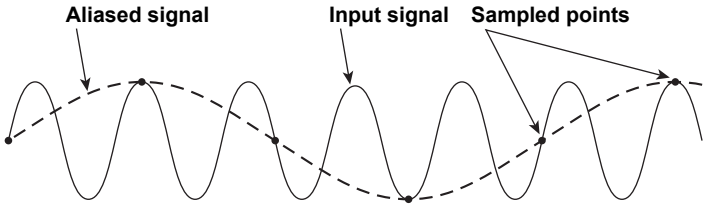
p-p Compression

p-p compression is the compression method used to derive waveform display data from waveform sampling data. For example, if a 2-Hz sine wave is measured at a data update rate of 1 s, to display this waveform, the WT1800 converts the number of data points from approximately 2,000,000 to 1602 (801 pairs of maximum and minimum values). Thus, two points (a pair) of waveform display data are derived from approximately 2500 points of waveform sampling data. This conversion is called p-p (peak-peak) compression. The compression ratio of p-p compression varies depending on the data update interval and the horizontal scale (time axis) of the waveform display.


Waveform sampling data
A/D-converted data
1 s
Number of data points: Approx. 2,000,000
p-p compression
Compresses approximately 2500 points of waveform sampling data to 2 points (extracts the maximum and minimum values and draws them in each raster)
Waveform display data (WT screen)
Vertical axis
Time axis
0
801 rasters
800
Number of data points: 1,602 (801 pairs)
With display interpolation on

Aliasing

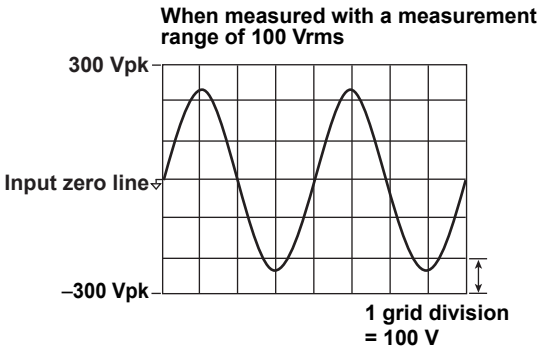
When the sample rate is low compared to the frequency of the input signal, the high frequency components of the signal are lost. In accordance with the Nyquist sampling theorem, the high frequency components in the signal are misread as low frequency components. This is called aliasing.

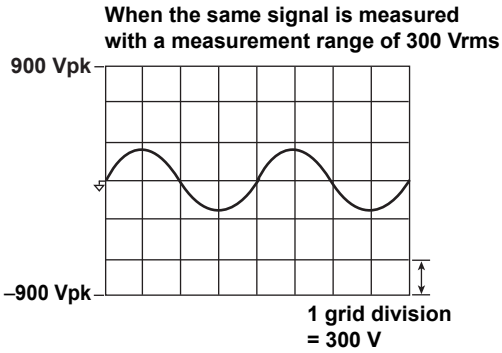


Vertical Axis (Amplitude)

The height (display range) of the vertical axis is based on the specified crest factor and measurement range. For example, if the crest factor is set to CF3 and the voltage measurement range is set to 100 Vrms, the display range is set to ±300 Vpk (±3 × 100 Vrms) with the zero input line at the center. The waveform is clipped if this range is exceeded.

In the same way, if the crest factor is set to CF6 and the voltage measurement range is set to 50 Vrms, the display range is set to ±300 Vpk (±6 × 50 Vrms) with the zero input line at the center.





Trigger (Trigger Settings)

The trigger determines when a waveform is displayed. A trigger is said to “occur” when the trigger condition is met and a waveform is displayed.

Trigger Mode (Mode)

The trigger mode determines the conditions for updating the display. Select from the following options.

- **Auto (Auto mode)**

  If the trigger conditions are met before an approximately 100 ms timeout, the WT1800 updates the displayed waveforms on each trigger occurrence. If not, the WT1800 automatically updates the displayed waveforms. If the period of the trigger signal is greater than 100 ms, the display is updated as the two conditions described above alternate. If this occurs, use Normal mode.
- **Normal (Normal mode)**

  The WT1800 only updates the waveform display when the trigger conditions are met. If no triggers occur, the display is not updated. If you want to view waveforms that the WT1800 cannot trigger on, or if you want to check the ground level, use Auto mode.
- **OFF**

  The trigger feature does not function. The display is updated at the data update interval. There are limitations on the waveform display feature.

  ▶ **Click here.**

Trigger Source (Source)

The signal that the WT1800 checks for the trigger condition is referred to as the trigger source. Select from the following options. The available options vary depending on the installed elements.
U1, I1, U2, I2, U3, I3, U4, I4, U5, I5, U6, I6, and Ext Clk (external clock)*

* When you select Ext Clk, the external signal applied to the external clock input connector (EXT CLK) on the rear panel is used as the trigger source. For the EXT CLK connector specifications, see section 4.3 in the getting started guide, IM WT1801-03EN. When Ext Clk is set as the trigger source, the trigger level setting is invalid.

Trigger Slope (Slope)

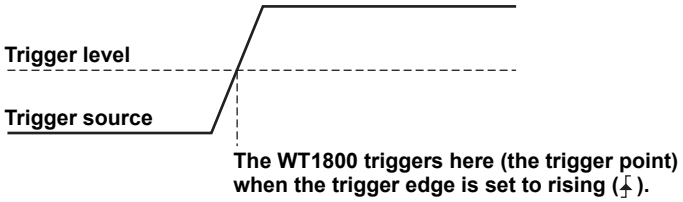
Slope refers to the signal movement from a low level to a high level (rising slope) or from a high level to a low level (falling slope). When the slope is used as one of the trigger conditions, it is called a trigger slope.
The following trigger slope settings are available for triggering the WT1800.

- ⎍: An edge is detected when the trigger source changes from a level below the trigger level to a level above the trigger level (rising).
- ⎎: An edge is detected when the trigger source changes from a level above the trigger level to a level below the trigger level (falling).
- ⎍⎎: The WT1800 triggers on both rising and falling edges.

Trigger Level (Level)

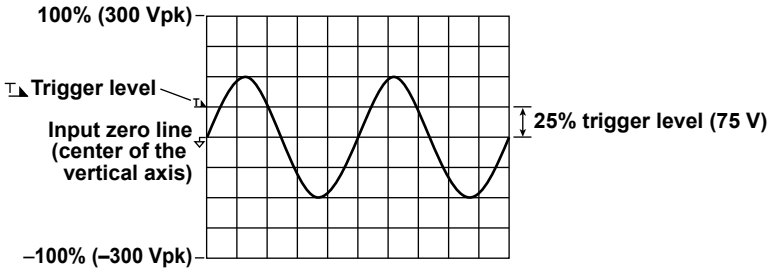
The trigger level is the level at which the trigger slope is determined. When the trigger source passes through the trigger level on a rising or falling edge, a trigger occurs.

- You can select a value between 0.0 and ±100.0%.
- A value of 100% corresponds to half the height of the waveform display. If the zero level of the input signal is set to the center of the vertical axis, 100% corresponds to the top of the waveform display, and –100% corresponds to the bottom of the waveform display. The upper and lower limits of the waveform display correspond to three times the voltage or current measurement range of each element when the crest factor is set to CF3 and six times when the crest factor is set to CF6. When scaling is used, the upper and lower limits correspond to three or six times the scaled ranges.
- When Ext Clk is set as the trigger source, the trigger level setting is invalid.



• **Measurement range: 100 Vrms or 50 Vrms when the crest factor is set to CF3 or CF6, respectively.**

• **Trigger level: 25%**

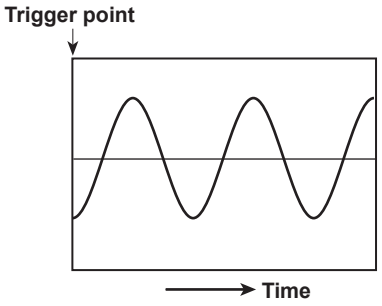


Trigger Point

The trigger point is the point at which a trigger occurs. The trigger point is always displayed at the left end of the screen.

After the trigger is activated, the waveform display continues from the left of the screen to the right of the screen with the passage of time.

(The arrow below the word “Trigger point” in the figure below is just for illustration. The arrow does not appear on the actual display.)



- To prevent noise-related errors, the trigger feature has a hysteresis of approximately 1% when the crest factor is set to CF3. For example, when the trigger slope is set to , a trigger will occur if the input signal level falls approximately 1% below the trigger level and then passes through the trigger level on a rising edge. The trigger feature has a hysteresis of approximately 2% when the crest factor is set to CF6.
- When integration is in progress or has been stopped, the trigger feature does not function. Therefore, the waveform display start point (the signal level at the left edge of the screen) may not be stable. Also, the numeric data measurement period may not be synchronized with the waveform data measurement period.

Advanced Waveform Display Settings (Display Settings)

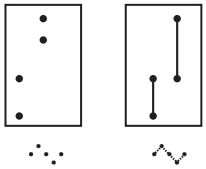
Display Interpolation (Interpolate)

When there are less than 800 points of sampled data on the time axis, the displayed points (rasters) do not connect with each other. Numbers of sampled points below 800 are said to be within the interpolation range. Display interpolation is a feature that connects the points linearly so that the waveform display is smooth. You can set the interpolation method to one of the settings below.

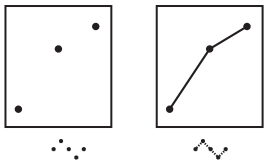
- : No interpolation is performed. Only the data points are displayed.
- : The spaces between data points are connected with straight lines.

- **Outside of the Interpolation Zone**

  The spaces between vertically aligned dots are filled. If the number of data points is 1602 or greater, the WT1800 determines the P-P compression values (the maximum and minimum sampled-data values in a given interval), and displays vertical lines (rasters) connecting each pair of maximum and minimum P-P compression values.



- **In the Interpolation Zone**



Grid (Graticule)

You can set the window grid to one of the following options.

- : The grid is displayed with dotted lines.
- : The grid frame is displayed.
- : The grid is displayed with a cross hair.

Turning the Scale Value Display On and Off (Scale Value)

You can select whether to display the following values for each waveform.

- The upper and lower limits of the vertical axis.
- The values at the left and right edges of the horizontal axis (time axis).

Turning the Display of Waveform Labels On and Off (Wave Label)

Select whether to display waveform labels.

Waveform Mapping (Wave Mapping)

Assignment Method (Mode)

You can assign waveforms to windows on the screen. Choose one of the following methods for assigning the waveforms to the windows.

- Auto
  The waveforms whose displays are turned on are assigned in order according to their element numbers, with an element's voltage waveform (U) coming first, followed by its current (I), speed, torque, Aux1, and then Aux2 waveform.[1, 2]
- Fixed
  Regardless of whether their displays are on or off, waveforms are assigned in order according to their element numbers, with an element's voltage waveform (U) coming before its current waveform (I). The speed and Aux1 waveforms appear in the top window.[1, 2] The torque and Aux2 waveforms appear in the second window from the top.[1, 2]
- User
  You can pick which waveforms to assign to which windows, regardless of whether the waveform's displays are on or off. You can set the display position to a number from 0 to 5. Number 0 corresponds to the window at the top of the screen, and the window number increases for each successively lower window.

1 Speed and torque waveforms are available on models with the motor evaluation option.
2 Aux1 and Aux2 waveforms are available on models with the auxiliary input option.

Display Item (ITEM)

Displaying All Waveforms (All ON)

The waveforms of all input signals are displayed.

Displaying No Waveforms (All OFF)

No waveforms are displayed.

Selecting Which Waveforms to Display (Display ON/OFF)

- You can select whether to display the waveform of each input signal of each element by selecting or clearing the signal's check box. Only the input signals of installed elements appear.
- On models with the motor evaluation option, you can turn the displays of the waveforms of the speed and torque input signals on and off.
- On models with the auxiliary input option, you can turn the displays of the waveforms of the Aux1 and Aux2 input signal on and off.

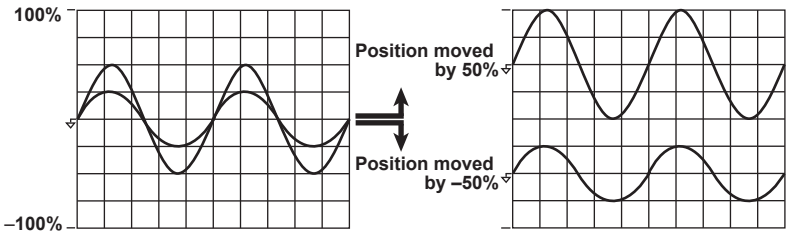
Vertical Zoom (Vertical Zoom)

Each displayed waveform can be scaled. You can select one of the following zoom factors:
0.1, 0.2, 0.25, 0.4, 0.5, 0.75, 0.8, 1, 1.14, 1.25, 1.33, 1.41, 1.5, 1.6, 1.77, 2, 2.28, 2.66, 2.83, 3.2, 3.54, 4, 5, 8, 10, 12.5, 16, 20, 25, 40, 50, or 100

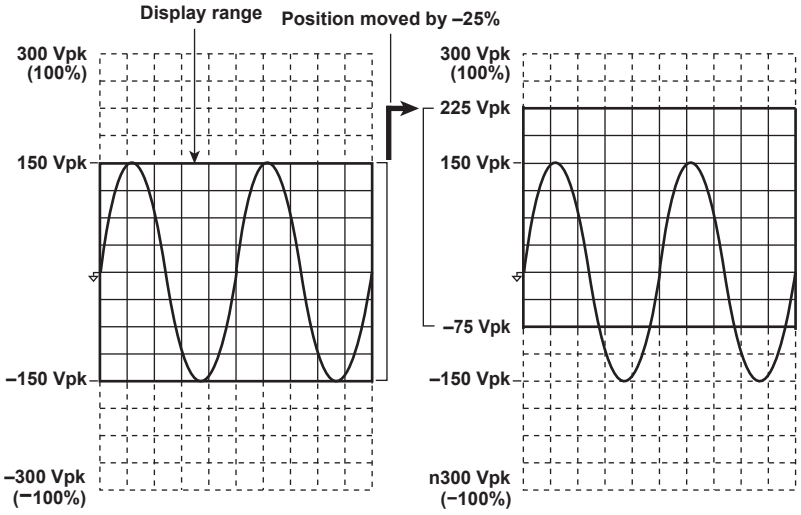
Vertical Position (Vertical Position)

You can vertically shift the displayed position (vertical position) of a waveform. This is useful when you want to view the relationship between voltage and current waveforms, or when the section of the waveform that you want to view does not fit into the display frame.

- You can select a value between 0.000 and ±130.000%.
- When the zoom factor is set to 1, a value of 100% corresponds to half the height (display range) of the waveform display (which is three or six times the measurement range when the crest factor is set to CF3 or CF6, respectively). The upper and lower vertical display limits of the screen are 100% and –100%.



- As shown in the figure below, when the zoom factor is set to a value other than 1, the upper and lower display limits of the screen do not correspond to three or six times the measurement range (or to ±100%) when the crest factor is set to CF3 or CF6, respectively. You must take the zoom factor into account when setting a waveform's position. In the figure below, the crest factor is set to CF3, the voltage range is 100 V, the zoom factor is 2, and the vertical position has been shifted by –25%. The waveform is shifted by the same amount that it would be if the zoom factor were set to 1 and the vertical position was shifted by –50%.



When you want to zoom in on part of a waveform, we recommend that you take the steps below.

1. Set the zoom factor to 1.
2. Following the instructions in this section for shifting a waveform's vertical position, shift the part of the waveform that you want to view to the center of the display.
3. Set the vertical zoom factor.

11 Trend Display

Other Displays (OTHERS)

You can press OTHERS to make the following displays appear.

- Trend display (Trend)
- Bar graph display (Bar)
- Vector display (Vector)
- Split display (with the numeric value display; Numeric+***)
- Split display (with the waveform display; Wave+***)
- Split display (with the trend display; Trend+***)
- High speed data capturing (High Speed Data Capturing)

Each time you press OTHER, the display switches in order between the trend display, the bar graph display (option), the vector display (option), and the split display (the split display that you set previously).*

* In the default split display setting, the numeric value display and waveform display are shown.

Trend Display (Trend)

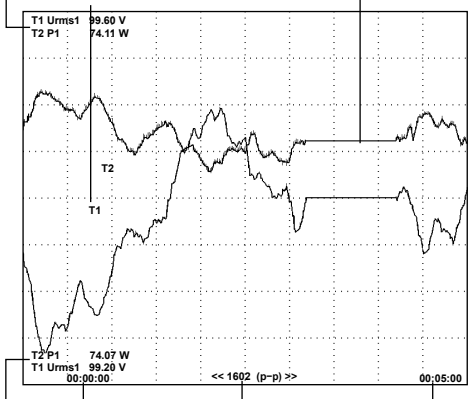
You can display the trends of measurement functions.

Trend Display Example

Scale Value
The trend number, measurement function, element, and upper limit of the displayed trend

When the display is held, trend values behave the same as numeric values. When the display is un-held, the trend data from when the display was held appears.

Waveform label



Time at the left edge of the screen (fixed at 0 seconds)

Time at the right edge of the screen (amount of time contained in the screen)

• The number of data points between the left and right edges of the display.
• "P-P"s indicates that the displayed trend has been P-P compressed.

Scale Value
The trend number, measurement function, element, and lower limit of the displayed trend

Display Format (FORM)

Number of Trend Display Windows (Format)

You can choose the number of windows from one of the following options:

- Single: No windows
- Dual: Two windows
- Triad: Three windows
- Quad: Four windows

Depending on the number of windows, the number of displayed points in each window changes as described below.

Single: 672 points, Dual: 336 points, Triad: 224 points, Quad: 168 points

When the screen is split, the number of displayed points along the vertical axis of a single window is halved.

Methods for Assigning Waveforms to Screens

Trends whose displays are turned on are assigned in numeric order (T1 to T16) to the split screens. The assignment method corresponds to the Auto option in the waveform display.

Time Axis (Time/div)

The time axis is set in Time/div (time per grid division). The time per division can be set in the range of 3 s to 1 day.

The trend data update interval is determined by the data update interval and the time axis (Time/div). For example, if the data update interval is 50 ms and you set Time/div to 3 s/div, the trend display is updated every 1 s. If you set the data update interval to 10 s and Time/div to 3 s/div, the trend display is updated every 10 s, and the trend data is displayed as a line graph, with each point separated by 10 s. If you set Time/div to 1 day/div, the trend display will be updated once every 1080 s regardless of the data update interval.

One division (1 div) on the trend display is equivalent to 80 rasters. For example, if you set Time/div to 1 day/div, one raster is 1080 s (which is equal to 1 day/80), the trend data update interval is 1080 s, and the displayed data is P-P compressed. For information about rasters and P-P compression, see “p-p Compression.”

▶ **Click here.**

Restarting Trends (Clear Trend Exec)

When you restart trends, the trend display up to that point is cleared, and the trends start over from the right end of the screen.

In addition to when you execute Clear Trend Exec, trends will also restart when:

- You change a trend display function, element, or harmonic (option) setting.
- You change the trend time axis (horizontal axis) setting.

Advanced Trend Display Settings (Display Settings)

These are the same as the advanced waveform display settings.

▶ **Click here.**

All advanced trend display settings are shared with the advanced waveform display settings. If you change the advanced settings in the trend display, the advanced settings in the waveform display also change. For example, if you set the display of the scale values to OFF in the trend display, the display of the scale values will also be set to OFF in the waveform display.

Display Item (ITEM)

Turning Trend Displays On and Off

Display (The upper left of the list)

You can set whether to display (All ON) or hide (All OFF) all trends, from trend 1 (T1) to trend 16 (T16).

Trend Numbers (T1 to T16)

You can select whether to display each trend, from trend 1 (T1) to trend 16 (T16), by selecting or clearing its check box.

Function (Function)

You can select any of the measurement functions listed under “Items That This Instrument Can Measure.”

▶ Click here.

Element (Element/Σ)

- You can select the element/wiring unit from the options below. The available options vary depending on the installed elements.
  Element1, Element2, Element3, Element4, Element5, Element6, ΣA, ΣB, and ΣC
- If there are no elements assigned to a selected wiring unit, because the wiring unit has no data, its trend is displayed at the top or bottom of the screen. For example, if elements are assigned to ΣA but not to ΣB, the trends of measurement functions for ΣB appear at the top or bottom of the screen.

Order (Order; option)

When you select a function that has harmonic data, you can set the displayed harmonic order within the following range.
Total (Total value) or 0 (DC) to 500

The orders that can be specified vary depending on the measurement function. For details, see “Harmonic Measurement Function Orders.”

▶ Click here.

The trends of orders that exceed the maximum measurable order are displayed at the top or bottom of the screen. For information about the maximum measurable harmonic order, see “Maximum Harmonic Order to Be Measured (Max Order).”

▶ Click here.

- Trends for which there is no corresponding numeric data are displayed at the top or bottom of the screen.
- If you choose to display the trend of a user-defined event (Ev1 to Ev8), the trend display shows 1 when the user-defined event is occurring and 0 when it is not occurring.

Trend Display Scale

Setting the Vertical Scale (Scaling)

You can set the upper and lower limits of a trend window. Set the display mode to one of the options below.

- Auto: The upper and lower limits of the trend window are automatically determined based on the maximum and minimum trend display data values.
- Manual: You can set the upper and lower limits manually.

Upper and Lower Limits for Manual Scaling (Upper Scale and Lower Scale)

You can set the upper and lower limits within the range of –9.9999 T to 9.999 T.

12 Bar Graph Display (Option)

Bar Graph Display (OTHERS (Bar))

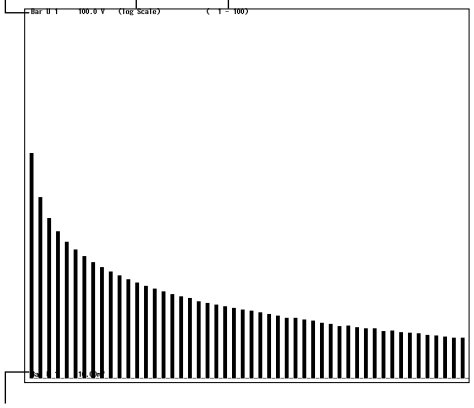
On models with the harmonic measurement option or the simultaneous dual harmonic measurement option, you can display harmonics using bar graphs. The harmonic orders are lined up on the horizontal axis, and the vertical axis represents the amplitude of each harmonic.
You can configure three different bar graphs.

Bar Graph Display Example

The bar graph number, measurement function, element, and upper limit of the displayed bar graph

"log Scale" only appears when logarithmic coordinates are used.

Harmonic order range of the displayed bar graph



The bar graph number, measurement function, element, and lower limit of the displayed bar graph

- When logarithmic coordinates are used (Log Scale), if a value is negative, its absolute value is displayed with a red bar graph.
- If the analysis window width (number of cycles of the fundamental signal) that is determined by the fundamental frequency is shorter than the data update interval, bar graphs are not displayed. Set a longer data update interval. For details, see "Notes about the Numeric Data Display."
  ▶ Click here.
- The bar graphs of harmonic orders that exceed the maximum measurable order are not displayed. For information about the maximum measurable harmonic order, see "Maximum Harmonic Order to Be Measured (Max Order)."
  ▶ Click here.

Display Format (FORM)

Number of Bar Graph Display Windows (Format)

You can choose the number of windows from one of the following options:

- Single: No windows. The data of bar graph (Item No.) 1 is displayed.
- Dual: Two windows. The data of bar graphs (Item No.) 1 and 2 is displayed.
- Triad: Three windows. The data of bar graphs (Item No.) 1 to 3 is displayed.

Bar Graph Display Range (Start Order/End Order)

- You can configure the range of harmonic orders to show in a bar graph.
- The range is the same for bar graphs 1 to 3.

Starting Harmonic Order (Start Order)

- You can select a value between 0 and 490. However, the starting harmonic order cannot be more than 10 orders less than the ending order.
- When the measurement function of a bar graph is Φ, order 0 has no values, so you cannot display it in the bar graph.
- When the measurement function of a bar graph is ΦU or ΦI, orders 0 and 1 have no values, so you cannot display them in the bar graph.

Ending Harmonic Order (End Order)

You can select a value between 10 and 500. However, the ending harmonic order cannot be more than 10 orders greater than the starting order. You cannot display bar graphs containing harmonic orders that are greater than the maximum measurable order (see section 6.6 in the getting started guide, IM WT1801-03EN).

Display Item (ITEM)

Bar Graph Number (Item No.)

Select the number, from 1 to 3, of the bar graph that you want to select.

Function (Function)

You can select the measurement function to display from the following options.
U, I, P, S, Q, λ, Φ, ΦU, ΦI, Z, Rs, Xs, Rp, and Xp

Element (Element)

You can select the element from the following options. The available options vary depending on the installed elements.
Element1, Element2, Element3, Element4, Element5, and Element6

Bar Graph Display Scale

Setting the Vertical Scale Mode (Scale Mode)

You can set the upper and lower limits of a bar graph window. Set the display mode to one of the options below.

- Fixed
  - When the function is U, I, P, S, or Q, the scaling is logarithmic (Log).
  - When the function is λ, Φ, ΦU, ΦI, Z, Rs, Xs, Rp, or Xp, the scaling is linear (Linear).
  - The upper and lower limits of the bar graph window are automatically determined based on the maximum and minimum displayed trend data values. The lower and upper limits for λ are –1 and 1. For Φ, ΦU, and ΦI, the minimum and maximum values are –180 to 180°. Negative values correspond to phase lagging and positive values correspond to phase leading.
- Manual
  You can set the type, upper limit, and X-axis position of the vertical scale.

Vertical Scale Type (Vertical Scale)

This setting is valid when the vertical scale mode is set to Manual. You can set the scale type to linear (Linear) or logarithmic (Log).

Upper Limit (Upper Scale)

This setting is valid when the vertical scale mode is set to Manual. You can set the upper limit to a value from 0 to 9.999 T.

X-Axis Position (X Axis Position)

This setting is valid when you set the vertical scale mode to Manual and the vertical scale type to Linear. You can set the point at which the Y-axis coordinate is 0 to Bottom (the bottom of the screen) or Center (the center of the screen).

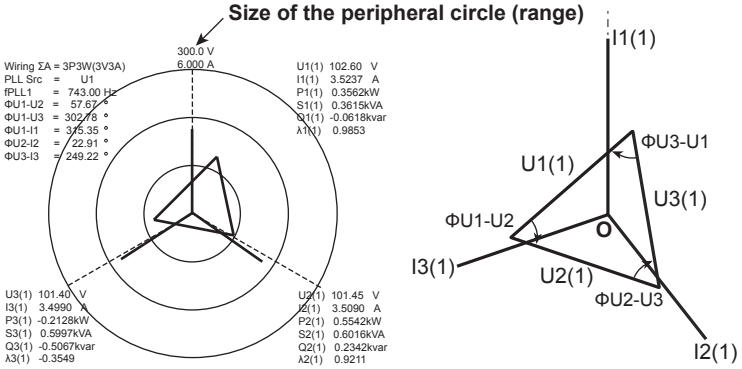
13 Vector Display (Option)

Vector Display (OTHERS (Vector))

On models with the harmonic measurement option or the simultaneous dual harmonic measurement option, you can select a wiring unit to display vectors of the phase differences and amplitudes (rms values) of the fundamental signals, U(1) and I(1), in each element in the unit. The positive vertical axis is set to zero (angle zero), and the vector of each input signal is displayed.

Vector Display Example

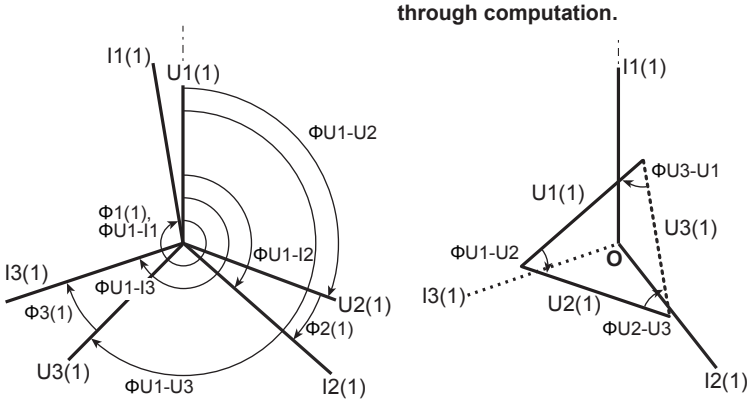
For a 3P3W system with a three-voltage, three-current method
- **U1(1), U2(1), and U3(1) are line voltages.**
- **I1(1), I2(1), and I3(1) are line currents.**



For a 3P4W (three-phase, four-wire system)
- **U1(1), U2(1), and U3(1) are line voltages.**
- **I1(1), I2(1), and I3(1) are line currents.**

For a 3P3W (three-phase, three-wire system)
- **U1(1), U2(1), and U3(1) are line voltages.**
- **I1(1), I2(1), and I3(1) are line c urrents.**

However, U3(1) and I3(1) are not actually measured for the 3P3W system. The vectors are displayed through computation.



If the analysis window width (number of cycles of the fundamental signal) that is determined by the fundamental frequency is shorter than the data update interval, vectors are not displayed. Set a longer data update interval. For details, see “Notes about the Numeric Data Display.”

▶ **Click here.**

Display Format (FORM)

Number of Vector Display Windows (Format)

You can choose the number of windows from one of the following options:

- Single: No windows. The data of vector (Item No.) 1 is displayed.
- Dual: Two windows. The data of vectors (Item No.) 1 and 2 is displayed. However, in the split display, the data of vector 1 is displayed.

Turning the Display of Numeric Data On and Off (Numeric)

You can select whether to show (ON) or hide (OFF) numeric data. You can display the size of each signal and the phase differences between signals. For information about phase difference display formats, see “Phase Difference Display Formats.”

▶ Click here.

Display Item (ITEM)

Vector Number (Item No.)

Select the vector you want to set: 1 or 2.

Element or Wiring Unit (Object)

You can select the element or wiring unit to display from the options below. The available options vary depending on the installed elements.

Element1, Element2, Element3, Element4, Element5, Element6, ΣA, ΣB, and ΣC

Setting Vector Zoom Factors (U Mag/I Mag)

You can change the sizes of the vectors. You can specify separate zoom factors for the fundamental waves U(1) and I(1). When you zoom a vector, the value for the size of the peripheral circle of the vector changes according to the zoom factor.

Setting the Zoom Factor of the Vector of Fundamental Waveform U (1) (U Mag)

You can set the zoom factor to a value between 0.100 and 100.000.

Setting the Zoom Factor of the Vector of Fundamental Waveform I (1) (I Mag)

You can set the zoom factor to a value between 0.100 and 100.000.

If the zoom factor is too large, the vector will exceed the display range and will not be displayed properly. Reduce the zoom factor so that the vector is displayed within the display range.

14 Split Display

Split Display (OTHERS)

You can split the screen into top and bottom halves, and select a display to show in each half. You can select the following items.

- Split displays with the numeric display (Numeric+***)
- Split displays with the waveform display (Wave+***)
- Split displays with the trend display (Trend+***)

Split Displays with the Numeric Display (Numeric+***)

Numeric data is displayed in the top half of the screen. Select the display to show in the bottom half of the screen from the following options.

- Wave: Waveform
- Trend: Trend
- Bar: Bar graph*
- Vector: Vector*

* This item is available on models with the harmonic measurement option or the simultaneous dual harmonic measurement option.

Split Displays with the Waveform Display (Wave+***)

Waveforms are displayed in the top half of the screen. Select the display to show in the bottom half of the screen from the following options.

- Numeric: Numeric data
- Trend: Trend
- Bar: Bar graph*
- Vector: Vector*

* This item is available on models with the harmonic measurement option or the simultaneous dual harmonic measurement option.

Split Displays with the Trend Display (Trend+***)

Trends are displayed in the top half of the screen. Select the display to show in the bottom half of the screen from the following options.

- Numeric: Numeric data
- Wave: Waveform
- Bar: Bar graph*
- Vector: Vector*

* This item is available on models with the harmonic measurement option or the simultaneous dual harmonic measurement option.

When the setup parameter list is displayed (the INPUT INFO key is lit), it appears in the top half of the screen, and the display that you assigned in the Others menu to the top window in the split display is displayed in the bottom half of the screen.

Split Display Settings

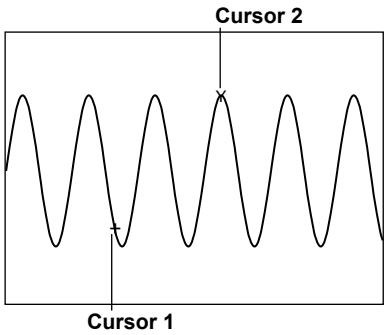
Press FORM to switch between the FORM menus of the display that you assigned to the top half of the screen in the split display and the display that you assigned to the bottom half of the screen in the split display. Likewise, press ITEM to switch between ITEM menus.

15 Cursor Measurement

Cursor Measurement (CURSOR)

You can place cursors on displayed waveforms, trends, and bar graphs and display the values at the cursor locations.

Example of cursors in the waveform display



You can set the following items.

- Turning Cursor measurement on and off (Cursor)
- Waveform measured by cursor 1 (C1+ Trace)
- Waveform measured by cursor 2 (C2x Trace)
- Cursor path (Cursor Path)
- Position of cursor 1 (C1+ Position)
- Position of cursor 2 (C2x Position)
- Linking cursor movement (Linkage)

Turning Cursor Measurement On and Off (Cursor)

- ON: Cursor measurement is performed.
- OFF: Cursor measurement is not performed.

Waveform Measured by Cursor 1 (+; C1+ Trace)

This item only appears in the waveform and trend displays. It does not appear in the bar graph display.

In the Waveform Display

You can select the waveform to measure with cursor 1 (+) from the following options. The available options vary depending on the installed elements.

U1, I1, U2, I2, U3, I3, U4, I4, U5, I5, U6, I6, Speed, Torque, Aux1, and Aux2[1, 2]

1 Speed and torque waveforms are available on models with the motor evaluation option.

2 Aux1 and Aux2 waveforms are available on models with the auxiliary input option.

In the Trend Display

You can set the trend to measure with cursor 1 (+) to a trend from T1 to T16.

Waveform Measured by Cursor 2 (x; C2x Trace)

You can select the waveform to measure with cursor 2 (x). The options are the same as those for cursor 1 (+; C1+ Trace).

▶ **Click here.**

Cursor Path (Cursor Path)

Because the WT1800 uses P-P compression on sampled data, two values (a maximum and a minimum value) are displayed at each time-axis point. You can choose the path that the cursors move through and the data points that are measured by the cursors from one of the options below.

- Max: Cursors move along and measure the maximum values on the time axis.
- Min: Cursors move along and measure the minimum values on the time axis.
- Mid: Cursors move through the middles of the maximum and minimum values on the time axis, and they measure the values in the middle of the maximum and minimum values.

This item only appears in the waveform display. It does not appear in the trend or bar graph display.

Position of Cursor 1 (+; C1+ Position)

Set the position of cursor 1 (+) to a value within one of the following ranges.

- Waveform display: 0 (the left edge of the screen) to 800 (the right edge of the screen)
- Trend display: 0 (the left edge of the screen) to 1601 (the right edge of the screen)
- Bar graph display: 0 (DC) to 500 (the 500th order)

Position of Cursor 2 (x; C2x Position)

Set the position of cursor 2 (x). The ranges within which you can set the position are the same as those for cursor 1 (+; C1+ Position).

▶ **Click here.**

Linking Cursor Movement (Linkage)

Set Linkage to ON to move cursor 1 (+) and cursor 2 (x) without changing the distance between them. Set the positions of the cursors by setting C1+Position.

Measured Items

In the Waveform Display

Y+	The vertical-axis (Y-axis) value of cursor 1 (+)
Yx	The vertical-axis (Y-axis) value of cursor 2 (x)
Y	The difference between the vertical-axis (Y-axis) values of cursor 1 (+) and cursor 2 (x)
X+	The horizontal-axis (X-axis) value of cursor 1 (+)
Xx	The horizontal-axis (X-axis) value of cursor 2 (x)
X	The difference between the horizontal-axis (X-axis) values of cursor 1 (+) and cursor 2 (x)
1/X	The reciprocal of the difference between the horizontal-axis (X-axis) values of cursor 1 (+) and cursor 2 (x)

In the Trend Display

Y+	The vertical-axis (Y-axis) value of cursor 1 (+)
Yx	The vertical-axis (Y-axis) value of cursor 2 (x)
ΔY	The difference between the vertical-axis (Y-axis) values of cursor 1 (+) and cursor 2 (x)
X+	The horizontal-axis (X-axis) value of cursor 1 (+) With the left edge of the screen being 0 seconds, the time from the left edge of the screen is indicated.
Xx	The horizontal-axis (X-axis) value of cursor 2 (x) With the left edge of the screen being 0 seconds, the time from the left edge of the screen is indicated.
ΔX	The difference between the horizontal-axis (X-axis) values of cursor 1 (+) and cursor 2 (x)
D+	The date and time at the position of cursor 1 (+) The date and time of measurement are displayed in this format: Year/Month/Day Hour:Minute:Second.
Dx	The date and time at the position of cursor 2 (x) The date and time of measurement are displayed in this format: Year/Month/Day Hour:Minute:Second.

- If immeasurable data exists, "***" is displayed in the measured value display area.
- ΔY can be measured even when the units of the cursors are different. The measured result will not have a unit.

In the Bar Graph Display

Y1+	The vertical-axis (Y-axis) value of cursor 1 (+) of bar graph 1
Y1x	The vertical-axis (Y-axis) value of cursor 2 (x) of bar graph 1
ΔY1	The difference between the vertical-axis (Y-axis) values of cursor 1 (+) and cursor 2 (x) of bar graph 1
Y2+	The vertical-axis (Y-axis) value of cursor 1 (+) of bar graph 2
Y2x	The vertical-axis (Y-axis) value of cursor 2 (x) of bar graph 2
ΔY2	The difference between the vertical-axis (Y-axis) values of cursor 1 (+) and cursor 2 (x) of bar graph 2
Y3+	The vertical-axis (Y-axis) value of cursor 1 (+) of bar graph 3
Y3x	The vertical-axis (Y-axis) value of cursor 2 (x) of bar graph 3
ΔY3	The difference between the vertical-axis (Y-axis) values of cursor 1 (+) and cursor 2 (x) of bar graph 3

Cursor Movement

In the Waveform Display

- Cursors move along the selected waveform.
- The unit of cursor movement is the amount of time contained in one screen ÷ 800.

- If immeasurable data exists, “***” is displayed in the measured value display area.
- ΔY can be measured even when the units of the cursors are different. The measured result will not have a unit.
- The range of the vertical axis that can be measured using cursors is within ±300% when the crest factor is set to CF3 and within ±600% when the crest factor is set to CF6.

In the Trend Display

- Cursors move along the selected trend.
- You can set the cursor position relative to the left edge of the screen in points, with the left edge itself being 0 points and the right edge being 1601 points.
- You can move through the displayed data one point at a time.

In the Bar Graph Display

- Two cursors (+ and x) are displayed in each graph (Graph1 to Graph3).
- You can set the cursor positions as orders.
- The bar graph display indicates what harmonic order each cursor is located in. For example:
  - The location of cursor 1 (+) is indicated in this format: “Order+:2.”
  - The location of cursor 2 (x) is indicated in this format: “Orderx:55.”
- The orders indicating the locations of cursors 1 (+) and 2 (x) are the same for each bar graph, from 1 to 3.

If immeasurable data exists, “***” is displayed in the measured value display area.

16 High Speed Data Capturing

High Speed Data Capturing (OTHERS(High Speed Data Capturing))

Models with the high speed data capturing option can measure every 5 ms and save the measured data to a file. Also, you can synchronize the WT1800 with another device during measurement by applying an external sync signal to the external start signal I/O (MEAS START) connector.

High speed data capturing takes advantage of the fact that in a balanced three-phase circuit, the instantaneous values of the three phases of the rms voltage (UrmsΣ), the rms current (IrmsΣ), and the power (PΣ) add up to a direct current. For a three-phase, three-wire system or three-phase, four-wire system, the WT1800 can measure the rms voltage (UrmsΣ), the rms current (IrmsΣ), and the power (PΣ) at a high response speed. In an unbalanced three-phase circuit, the measured values fluctuate. This indicates that the power consumed by the load varies instantaneously.

When the measured values fluctuate, you can stabilize the measured voltage (U), current (I), and power (P) values for each element and the measured UmeanΣ, ImeanΣ, Ur-meanΣ, and Ir-meanΣ values for each wiring unit by setting a low cutoff frequency for the HS filter. However, if you set a low cutoff frequency for the HS filter, the response to changes in the measured values becomes slower.

Display Indications for High Speed Data Capturing

File Recording State **High Speed Data Capturing State**

High Speed Data Capturing State

- **Ready**
  - “Ready” appears when high speed data capturing has been reset and the WT1800 is ready to begin high speed data capturing.
  - When the number of data captures has been set to a value other than Infinite, the number of data captures appears to the right of Count.

Ready

Number of data captures

- **Start**
  - “Start” appears when high speed data capturing has been started.
  - The number of data captures that have been performed appears to the right of “Captured.”

Start

Number of times data has been captured

- **Init(Initialize)**
  - “Init” appears when high speed data capturing is being initialized.
  - A bar appears that indicates the initialization progress.
  - The time remaining for the initialization appears to the right of “Remaining.”

Init

Initialization progress

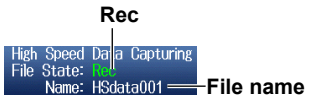
Remaining initialization time

File Recording State

This indication appears when you set Record to File to ON.

- **Ready**
  - "Ready" appears when recording to a file is possible and the WT1800 is ready to begin high speed data capturing.
  - Ready appears when you stop high speed data capturing and all processing for recording to a file finishes.

- **Rec(Record)**
  - "Rec" appears when the WT1800 has begun recording to a file and while the WT1800 is regularly recording data.
  - The name of the file that is being recorded to appears to the right of "Name."



- **Stop**

  "Stop" appears when the WT1800 has finished recording to a file and when recording to a file is stopped.

- **Error**
  - When a write error occurs while the WT1800 is recording to a file, the WT1800 stops recording to the file, and "Error" appears.
  - The measurement operations for high speed data capturing continue without stopping.

Initializing High Speed Data Capturing

- High speed data capturing is initialized when:
  - You switch from normal measurement to high speed data capturing.
  - You change one of the following settings.
    - A voltage or current measurement mode
    - Whether the HS filter is on or off
    - The HS filter's cutoff frequency
    - Trigger
    - Fundamental measurement conditions such as the measurement range and wiring system.
- The time required for initialization is as indicated below. For example, when the cutoff frequency is 1 Hz, the time required for initialization is approximately 2.7 s.

$$\frac{2.7}{\text{The HS filter's cutoff frequency}}\ \text{[s]}$$

  However, when the above formula results in a value of 250 ms or less, the time required for initialization is 250 ms.

Measurement Functions

For the symbols and meanings of the measurement functions that you can measure using high speed data capturing, see "High Speed Data Capturing Measurement Functions" under "Items That This Instrument Can Measure."

▶ **Click here.**

Data Capturing Interval

The interval at which data is captured varies as shown below depending on how External Sync is set.

- When External Sync is set to OFF: 5 ms
- When External Sync is set to ON: The interval at which data is captured depends on the sync signal that is applied to the external start signal I/O (MEAS START) connector. The WT1800 can sync with a signal whose period is 1 ms to 100 ms.

Display Update Rate

The display update rate is approximately 1 s.

Numeric Data Display

The numeric data for each measurement function that was last measured within the display update interval is displayed.
You cannot make individual changes to the displayed measurement functions. Use the PAGE UP and PAGE DOWN keys to change the display.
The number of pages varies as indicated below depending on the installed options.

Motor Evaluation Function	External Signal Input	Number of Pages
Not installed	Not installed	2 pages
Installed	Not installed	4 pages
Not installed	Installed	4 pages

- If the measured value exceeds 300%, “-OL-” (for over range) is displayed for U or I. When you are measuring with the highest measurement range, if the measured value exceeds 140%, “-OL-” (for over range) is displayed for U or I.
- If the measured value for the voltage or current is over range, “-OL-” (for over range) is displayed for P.
- “-OL-” (for over range) is displayed for UΣ if even one of the measured voltage values for an input element in a single wiring unit is over range. The same is true for IΣ and PΣ.
- UΣ and IΣ are displayed as zero when they are the following percentage of the maximum voltage range or current range out of the input elements assigned to the same wiring unit.
  - When the Crest Factor Is Set to CF3
    0.3% or less for Urms and Irms. 2% or less for Umn, Urmn, Imn, and Irmn.
  - When the Crest Factor Is Set to CF6
    0.6% or less for Urms and Irms. 4% or less for Umn, Urmn, Imn, and Irmn.

Fundamental Measurement Conditions

All the settings for the fundamental measurement conditions for high speed data capturing are the same as those for normal measurement.
However, the following limitations apply to the wiring system and line filter.

Wiring System during High Speed Data Capturing

- When the wiring system is set to one of the following settings, you can measure the voltage (U), current (I), and power (P).
  - 1P2W: Single-phase, two-wire system
  - 3P4W: Three-phase, four-wire system
  - 3P3W (3V3A): Three-voltage, three-current method
- When the wiring system is set to one of the following settings, the voltage (UΣ), current (IΣ), and power (PΣ) for the wiring unit are not measured and are displayed as "-------" (no data). When the wiring system is being set or high speed data capturing has been started, an error message appears.
  - 1P3W: Single-phase, three-wire system
  - 3P3W: Three-phase, three-wire system

Line Filter for High Speed Data Capturing

- You can also set a line filter for high speed data capturing. The setting is not shared with normal measurement. Even if you change the line filter setting during high speed data capturing, the line filter setting for normal measurement will remain unchanged.
- In high speed data capturing, the line filter is always on. You cannot select OFF. The LINE FILTER key and the Line Filter indicator at the top of the screen illuminate.
- You can set the cutoff frequency within the following range. For normal measurement, you can select 1 MHz, but you cannot select 1 MHz for high speed data capturing.
  0.1 kHz to 100.0 kHz (in 0.1 kHz steps), 300 kHz

Limitations on Setting Changes during High Speed Data Capturing

During high speed data capturing, there are some settings that you cannot change and functions that you cannot execute. For details, see appendix 10 in the getting started guide, IM WT1801-03EN.

High Speed Data Capturing (HS) Settings (FORM)

The high speed data capturing (HS) settings are listed below.

- Number of data captures (Capture Count)
- Viewing and optimizing the maximum capturing count (Optimize Count)
- Capture control settings (Control Settings)
- Recording to a file (Record to File)
- Starting and stopping high speed data capturing (Start/Stop)

Number of Data Captures (Capture Count)

The number of captures can be set to infinity or to a value from 1 to 10000000.

Viewing and Optimizing the Maximum Capturing Count (Optimize Count)

- The WT1800 computes the maximum capturing count for the save destination of the captured data file according to the number of numeric data items specified in Item Settings.
- You can set the capturing count to a value from 0 to the computed maximum capturing count.
- If you select Set, the maximum capturing count is set to the number of data captures. However, you cannot do this if the current number of data captures is 0.
- This setting is not valid when Record to File is set to OFF.

- If you enable automatic CSV conversion (Auto CSV Conversion) and set the storage destination for the high speed data capturing files to a USB memory device, the maximum capturing count is computed with approximately 20% of the available USB memory designated as valid for the high speed data capturing files (*.WTS and *.HDS files).
- When the maximum capturing count is displayed as 0, the save destination device for the high speed data capturing file does not have enough free space. Make more space available, by deleting files for example.
- If you change the number of numeric data items specified in Item Settings after you set the number of data captures, the maximum capturing count will change, and you will need to set the number of data captures again.

Capture Control Settings (Control Settings)

Voltage and Current Measurement Modes (U/I Measuring Mode)

Select the modes for measuring voltage and current.

Setting

Select the method for setting the voltage and current measurement modes from the following options.

- Each: Set the mode separately for the voltage and current of each input element.
- All: Set the mode for the voltages and currents of all installed input elements at the same time.

U1 to I6

Select the voltage and current measurement modes from the following options.
rms, mean, dc, r-mean

For details about how the voltage and current values are determined in each measurement mode, see appendix 1 in the getting started guide, IM WT1801-03EN.

The voltage or current measurement mode (rms, mean, dc, r-mean)

If the voltage and current measurement mode settings differ for elements assigned to the same wiring unit, the voltage (UΣ) and current (IΣ) of the wiring unit are not measured and are displayed as "-------" (no data).

HS Filter (HS Filter)

Turning on the HS (high speed) filter stabilizes the measured values. The HS filter averages the measured values. The HS filter is different from the line filter.

Set whether to enable the HS filter, and set the cutoff frequency. You can set the cutoff frequency within the following range.
1 Hz to 1000 Hz (in 1 Hz steps)

Selecting OFF disables the HS filter.

You can stabilize the measured voltage (U), current (I), and power (P) values for each element and the measured UmeanΣ, ImeanΣ, Ur-meanΣ, and Ir-meanΣ values for each wiring unit by specifying a low cutoff frequency for the HS filter. However, the response to changes in the measurement data becomes slower.

Trigger (Trigger Settings)

The trigger is what starts high speed data capturing. The act of starting high speed data capturing when the trigger conditions are met is referred to as “triggering.”

All the trigger settings for high speed data capturing are shared with those for displaying waveforms. If you change these settings in the menu for high speed data capturing, the waveform display trigger settings will also change. For example, if you set the trigger mode to off in the high speed data capturing menu, the trigger mode for waveform display will also be set to OFF.

Trigger Mode (Mode)

This setting is the same as the waveform display trigger mode setting.

▶ Click here.

Trigger Source (Source)

This setting is the same as the waveform display trigger source setting.

▶ Click here.

Trigger Slope (Slope)

This setting is the same as the waveform display trigger slope setting.

▶ Click here.

Trigger Level (Level)

This setting is the same as the waveform display trigger level setting.

▶ Click here.

External Sync (External Sync)

You can synchronize the WT1800 with another device during measurement by applying an external sync signal to the external start signal I/O (MEAS START) connector.

- OFF: The WT1800 does not synchronize with an external start signal but instead captures data every 5 ms.
- ON: The WT1800 captures data in sync with an external start signal.

For the specifications of the external start signal I/O connector , see section 4.4 in the getting started guide, IM WT1801-03EN.

- When External Sync is set to ON, the trigger settings are invalid. The trigger feature operates as if the trigger mode was set to OFF.
- To measure in sync with an external signal, set External Sync to ON and apply a number of pulses equal to or greater than the specified number of data captures + 1 to the external start signal I/O (MEAS START) connector.
- To synchronize multiple WT1800s and perform high speed data capturing, synchronize a WT1800 on which External Sync has been set to ON to a WT1800 on which External Sync has been set to OFF. When you synchronize the WT1800s, make sure that they are set to the same number of data captures.

Recording to a File (Record to File)

- If you set Record to File to ON, when high speed data capturing starts, the WT1800 saves the following two files in binary format.
  - High speed data capturing data file (.WTS): The measured data is saved to this file.
  - High speed data capturing header file (.HDS): The measurement conditions, settings, and recording information are saved to this file.
- File name extensions are added automatically.
- The file recording state (File State) appears in the upper left of the screen. The file recording state appears as “Ready,” “Rec,” “Stop,” or “Error,” depending on the state of high speed data capturing.
- If you set the save destination to a USB memory device, a high speed data capturing data file (.WTS) can contain up to 1 GB of data or 10,000,000 data captures.
- The WT1800 cannot load the measurement data that has been recorded on a file.

- Under the following circumstances, recording to a file stops, and the file recording state changes to Stop. The measurement operations for high speed data capturing continue without stopping.
  - When the file save destination runs out of free space.
  - When the size of the high speed data capturing data file exceeds the maximum value (1 GB).
  - When high speed data capturing is performed 10,000,000 times.
- Do not output captured data through communication and record it to a file at the same time. Doing so can lead to a reduction in the communication output speed and a reduction in the recording speed, can cause recording to a file to stop, and can make the file recording state change to Error.
- In the following circumstances, it is possible for the data update speed to surpass the speed at which the file is being recorded to, for recording to the file to stop, and for the file recording state to change to Error.
  - When you perform consecutive operations in the setup menu.
  - When the WT1800 receives consecutive communication commands.
  - When you operate the WT1800 over FTP.
  - When you save to a USB memory device with a slow write speed.
- When the write speed to the USB memory device that has been specified as the save destination is slow, the data update speed exceeds the speed at which the file is being recorded to, and recording to the file stops, you may be able to remedy the situation by using the methods described below.
  - Reduce the number of items that are being saved.
  - Using a faster USB memory device.
- When it takes a long time for data to be written to the USB memory device, recording to the file may be stopped forcefully, and some data may not be saved. When this happens, the file state indication is "Error."
- Conversion to ASCII format (.csv) uses a pair of files that consists of a high speed data capturing data file (.wts) and a high speed data capturing header file (.hds) with the same name. Do not change the names of high speed data capturing data files (.wts) and high speed data capturing header files (.hds) for different sets of data to the same name. If you do so, the WT1800 may malfunction and the USB memory may be damaged when you convert the data to ASCII format (.csv).
- If you disconnect a USB memory device while a file is being recorded to and the file recording state changes to Error, the high speed data capturing file may be incomplete or damaged. If this is the case, you will not be able to convert the data to ASCII format (.csv). Be sure to only disconnect the USB memory device when the file recording state is Ready.
- When you turn off the WT1800 power, the contents of the internal RAM disk are lost. Save the contents of the RAM disk to a USB memory device or network drive before you turn off the WT1800.
- Please be aware that the number of times that you can write to USB memory is limited.

Save Conditions (File Settings)

File List Display and Save Destination Settings (File List)

On the file list, specify the save destination for the measured data. You can set the storage medium to the internal RAM disk or to a USB memory device. You cannot set the storage medium to a network drive. For information about how to configure the file list display and how to operate files and folders, see “File Operations (Utility).”

▶ Click here.

If you set the storage medium to a USB memory device, when you remove the USB memory device, the storage medium automatically changes to the internal RAM disk.

Automatic CSV Conversion (Auto CSV Conversion)

You can choose whether to automatically create an ASCII format high speed data capturing file (.csv) from the high speed data capturing data file (.wts) and the high speed data capturing header file (.hds) that are saved when high speed data capturing stops.

- When the storage destination is the internal RAM disk ([RAM-0])
  A CSV file is created in the root folder of the USB memory device whose ID number is 0 ([USB-0]). An error message appears when USB memory is not connected.
- When the storage destination is a USB memory device ([USB-0] or [USB-1])
  A CSV file is saved in the same folder as the high speed data capturing data file.

The WT1800 will not create a CSV file whose size exceeds 2 GB but will instead create a CSV file for 2 GB worth of captured data. To convert the data into a CSV file whose size exceeds 2 GB, use the file reader software available from the following Yokogawa webpage.
http://www.yokogawa.com/jp-ymi/tm/F-SOFT/wtfs/wtfs1.htm

Saved Items (Item Settings)

Select whether to store a numeric data item by selecting or clearing its check box.

Items for which there is no measurement data are displayed as “-------” (no data), and no data is saved for them.

Automatic File Naming (Auto Naming)

This is the same as the auto naming feature for saving and loading data.

▶ Click here.

File Name (File Name)

This is the same as the file name setting for saving and loading data.

▶ Click here.

Comment (Comment)

This is the same as the comment setting for saving and loading data.

▶ Click here.

Manually Converting to CSV Format (CSV Convert)

You can convert the selected high speed data capturing data to ASCII format (.csv). This menu item appears when you press File List to display the file list.

- When you convert high speed data capturing data on the internal RAM disk ([RAM-0])
  A CSV file is created in the root folder of the USB memory device whose ID number is 0 ([USB-0]). An error message appears when USB memory is not connected.
- When you convert high speed data capturing data on a USB memory device ([USB-0] or [USB-1])
  A CSV file is saved in the same folder as the high speed data capturing data file that is being converted.

Starting and Stopping High Speed Data Capturing (Start/Stop)

Starting High Speed Data Capturing (Start)

- High speed data capturing starts.
- When high speed data capturing starts, the following operations are performed.
  - If the trigger mode is set to OFF, data is captured.
  - If the trigger mode is set to Auto or Normal, the WT1800 waits for a trigger to occur. When a trigger occurs, the WT1800 begins capturing data.
  - “HS State: Start” appears in the upper right of the screen.
  - When recording to a file is enabled, the WT1800 creates a high speed data capturing data file (.WTS) and a high speed data capturing header file (.HDS). “File State: Rec” and the file name appear in the upper left of the screen.

While “File State: Rec” is displayed, the storage medium is constantly being accessed, even though the icon that indicates this is not displayed, so do not remove the USB memory device or turn off the power. Doing so may damage the storage medium and corrupt its data.

Stopping High Speed Data Capturing (Stop)

- High speed data capturing stops.
- When high speed data capturing stops, the following operations are performed.
  - "HS State: Ready" appears in the upper right of the screen.
  - When recording to a file is enabled, the WT1800 finishes writing to the high speed data capturing data file (.WTS) and high speed data capturing header file (.HDS) and closes them. "File State: Ready" appears in the upper left of the screen.
  - When recording to a file and automatic CSV conversion are enabled, the WT1800 creates an ASCII format high speed data capturing file (.CSV).

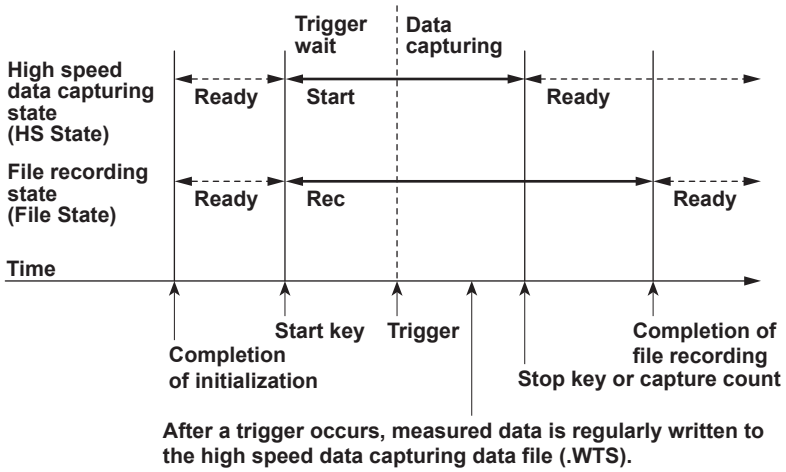
Automatically Stopping High Speed Data Capturing

- After the specified number of high speed data captures have been made, high speed data capturing automatically stops.
- The same operations are performed as those listed above for when high speed data capturing stops.

- When External Sync is set to ON and the following conditions regarding the external start signal applied to the WT1800 are met, high speed data capturing automatically stops.
- When the external start signal is not applied for 1 s or longer.
- When the period of the external start signal is less than 1 ms.

High Speed Data Capturing Operations

Examples for when the trigger mode is Auto or Normal.



Display Items (ITEM)

Number of Columns (Column Num)

You can select four or six columns.

Column Number (Column No.)

Select the number of the column that you want to configure.

Element (Element/Σ)

This is the same as the element (Element/Σ) item in the Matrix display.

▶ **Click here.**

Directly Selecting Elements (ELEMENT)

This is the same as direct element selection in the 4-, 8-, and 16-value displays.

▶ **Click here.**

Resetting the Settings (Reset Items Exec)

Reset the column settings.

Turning the Display Frame On and Off (Display Frame)

This is the same as turning the display frame on and off in the 4-, 8-, and 16-value displays.

▶ **Click here.**

Displaying Peak Over-Range Occurrence Information (Display Peak Over Status)

You can select whether to show (ON) or hide (OFF) peak over-range occurrence information.

Peak Over-Range Occurrence Information (Peak Over Status)

- If a peak over-range occurs in an input signal even once from the time when high speed data capturing starts until it stops, the input signal is displayed in red.

  Display example for when a peak over-range has occurred in U1 and I2.

- When display frames for measured values are displayed, display frames of measured values within which a peak over-range has occurred are displayed in red.
- Even if you stop high speed data capturing, the peak over-range occurrence information does not disappear. The peak over-range occurrence information will disappear (be reset) when after you stop high speed data capturing, you restart high speed data capturing or change the settings.

The input peak over-range indicator in the center of the top section of the screen lights in red when a peak over-range occurs.

17 Data Storage

You can store numeric data in binary format to the internal RAM disk or a USB memory device. You can store the data at the data update interval or at a specified time interval. You can convert stored binary data to ASCII (.csv) format. You can analyze the converted data on a PC. You cannot use the WT1800 to recall stored data.

Storage-Related Display Indications

When the storage state is any state other than that of being reset, the storage state and store count appear in the upper left of the screen.

Start

Storage has been started.

Stop

Storage has been stopped.

Ready

The storage mode is real-time storage mode, integration-synchronized storage mode, or event-synchronized storage mode, and the WT1800 is ready to begin storing.

Cmpl (Complete)

- The WT1800 has completed the specified number of storage operations.
- The WT1800 is in real-time storage mode and the scheduled storage stop time has passed.

When storage is reset, no storage state is displayed in the upper left of the screen.

Limitations on Changing the Settings during Storage

While data is being stored, there are some settings that you cannot change and functions that you cannot execute. For details, see appendix 9 in the getting started guide, IM WT1801-03EN.

Storage Conditions (STORE SET)

The following storage configuration menus are available.

- Storage control (Control Settings)
- Stored items (Item Settings)
- Save conditions (File Settings)

Storage Control (Control Settings)

Storage Mode (Store Mode)

You can choose from one of the following methods for starting and stopping storage.

- **Manual (Manual storage mode)**
  When you press STORE START, numeric data is stored at the storage interval for the number of times specified by the storage count.
- **Real Time (Real-time storage mode)**
  Storage starts after you press STORE START and the scheduled storage start time is reached. You can store numeric data at the storage interval until the storage stop time (or just the storage count) is reached.
- **Integ Sync (Integration-synchronized storage mode)**
  - Storage starts after you press STORE START and integration starts. You can store numeric data at the storage interval until integration stops (or just until the storage count is reached) is reached.
  - Storage continues even when integration is reset by the integration timer. When the integration timer is reset, the storage interval timer is also reset.

When independent integration is enabled, storage cannot be performed in integration-synchronized storage mode.

- **Event (Event-synchronized storage mode)**
  Storage starts after you press STORE START, the measured data is updated, and a user-defined event occurs. You can store numeric data each time the measured data is updated until the storage count is reached.
- **Single Shot (Single-shot storage mode)**
  Numeric data is stored whenever you press STORE START. You can store numeric data until the storage count is reached.

Storage Count (Store Count)

- The storage count can be set to infinity or to a value from 1 to 9999999.
- When the storage count is set to infinity, it is set to 9999999.
- Storage will stop before the specified storage count if the storage destination runs out of available memory or the stored data size exceeds the maximum value (1 GB).

Viewing and Optimizing the Maximum Storage Count (Optimize Count)

- The WT1800 computes the maximum storage count for the storage destination according to the number of data types specified in the Item Settings.
- You can set the storage count to a value from 0 to the computed maximum storage count.
- You can select Set to set the maximum storage count to the current storage count. However, you cannot do this if the current storage count is 0.

- If you enable automatic CSV conversion (Auto CSV Conversion) and set the storage destination to a USB memory device, the maximum storage count is computed with 20% of the available USB memory designated as valid for stored data (*.WTS and *.HDS files).
- If the maximum storage count is displayed as 0, there is not enough available memory in the storage destination. Make more space available, by deleting files for example.
- If you change the number of stored items specified in Item Settings after you set the storage count, the maximum storage count will change, and you will need to set the storage count again.

Storage Interval (Interval)

You can set the interval at which numeric data is stored.

- You can set the hour, minute, and second within the following range. If you set the interval to 00:00:00, the numeric data will be stored at the numeric data update interval.
  00:00:00 to 99:59:59
- When the storage mode is set to Integ Sync, storage continues even when integration is reset by the integration timer. When the integration timer is reset, the storage interval timer is also reset.
- This setting is invalid when the storage mode is set to Event or Single Shot.

Scheduled Storage Times for Real-Time Storage Mode (Real Time Control)

These settings are only valid when the storage mode is set to Real Time. You can set the year, month, day, hour, minute, and second of the storage start and stop times. Be sure to set the storage stop time to a time after the storage start time. You can set the values within the following ranges.

- Year: Any four-digit Gregorian calendar value
- Hour:Minute:Second: 00:00:00 to 23:59:59
- Now: The scheduled storage start time is set to the current time.
- Copy: The scheduled storage start time is copied into the scheduled storage stop time.

- You can set the day for the scheduled start or stop time in February to a value as high as the 31st day. If you do so, an error message will appear when you start storage. Reset the scheduled start and stop times.
- The WT1800 recognizes leap years when it executes the storage operation.

Trigger Event for Event-Synchronized Storage Mode (Trigger Event)

This setting is only valid when the storage mode is set to Event. You can select the user-defined event whose occurrence will cause storage to start. If you select a disabled user-defined event, storage cannot start.
For information about configuring user-defined events, see “User-Defined Events.”

▶ **Click here.**

Storage of the Numeric Data at Store Start (Store At Start)

- Select whether to store the numeric data at store start.
- You can configure this setting when:
  - The storage mode is set to Manual, and the storage interval is not 00:00:00.
  - The storage mode is set to Real Time, and the storage interval is not 00:00:00.
  - The storage mode is set to Integ Sync.

Stored Items (Item Settings)

You can set which numeric data items to store. You can choose to store the displayed numeric items (Displayed Numeric Items) or the selected items (Selected Items).

Displayed Numeric Items (Displayed Numeric Items)

The numeric data items displayed on the screen are stored. The stored items vary as indicated below depending on the display.

- When Numeric Values Are Displayed in the 4-, 8-, or 16-Value Display or the Matrix Display
  All the measurement functions on the page that is displayed when storage starts are stored in the order that they are displayed.
- When Numeric Values Are Displayed in the Single or Dual Harmonics List
  In addition to the data described above, the data of harmonics that are not displayed on the screen is stored up to the maximum measurable order (Max Order).
- When Numeric Values Are Displayed in the All Items or Custom Display
  Storage cannot be performed. An error message is displayed at store start.
- In Non-Numeric Displays (Waveform display, trend display, etc.)
  The WT1800 stores data according to the numeric display settings. For example, when the waveform display is shown, if the 16-value display would appear when you pressed NUMERIC, then the data for the measurement functions on the page of the 16-value display that would appear is stored.

During storage, even if you change the numeric data display format or the displayed items, the data is stored according to the numeric data that was displayed at store start.

Selected Items (Selected Items)

You can select the types of numeric data to store. To select which types of numeric data to store, click Items.

Items (Items)

If you set the numeric data items to store to Selected Items, you can select which types of numeric data to store.

Element (Element)

To select an element or wiring unit that you want to store the data of, select or clear its check box. You can select from the following options.
Element1, Element2, Element3, Element4, Element5, Element6, ΣA, ΣB, and ΣC

Function (Function)

Select whether to store the data of a function by selecting or clearing its check box. You can select any of the measurement function types listed under “Items That This Instrument Can Measure.”

▶ Click here.

Selecting All Functions (All ON)

The data of all measurement functions is stored.

Deselecting All Functions (All OFF)

None of the data for any of the measurement functions is stored.

Preset 1 (Preset 1)

The data of the following measurement functions is stored for all elements and wiring units.*
Urms, Irms, FreqU, FreqI, P, S, Q, λ, and Φ

Preset 2 (Preset 2)

The data of the following measurement functions is stored for all elements and wiring units.*
WP, WP+, WP–, q, q+, q–, Time, WS, and WQ

* If the wiring system setting (Wiring) is configured so that a wiring unit does not exist, the data for the functions of that wiring unit is not stored. For example, if ΣC does not exist, the data for ΣC is not stored.

Save Conditions (File Settings)

- Stored measurement data is saved to files in binary format (with .wts extensions).
- Measurement conditions, settings, and storage information are saved in binary format to header files (with .hds extensions).
- File name extensions are added automatically.
- When the storage destination is a USB memory device, the maximum stored data file (.wts) file size is 1 GB.
- You cannot load stored data using the WT1800.

▶ Click here.

Displaying a File List and Specifying the Save Destination (File List)

On the file list, specify the save destination. You can set the storage medium to the internal RAM disk or to a USB memory device. You cannot set the storage medium to a network drive. For information about how to configure the file list display and how to operate files and folders, see “File Operations (Utility).”

▶ Click here.

If you set the storage medium to a USB memory device, when you remove the USB memory device, the storage medium automatically changes to the internal RAM disk.

Automatic CSV Conversion (Auto CSV Conversion)

You can choose whether to automatically create an ASCII format stored data file (.csv) from the stored data file (.wts) and the header file (.hds) that are saved when storage finishes or is reset.

- When the storage destination is the internal RAM disk ([RAM-0])
  A CSV file is created in the root folder of the USB memory device whose ID number is 0 ([USB-0]).
- When the storage destination is a USB memory device ([USB-0] or [USB-1])
  A CSV file is saved in the same folder as the stored data file.

Automatic File Naming (Auto Naming)

This is the same as the auto naming feature for saving and loading data.

▶ Click here.

File Name (File Name)

This is the same as the file name setting for saving and loading data.

▶ Click here.

Comment (Comment)

This is the same as the comment setting for saving and loading data.

▶ Click here.

Manually Converting to CSV Format (CSV Convert)

You can convert the selected stored data to ASCII format (.csv). This menu item appears when you press File List to display the file list.

- When you convert stored data on the internal RAM disk ([RAM-0])
  A CSV file is created in the root folder of the USB memory device whose ID number is 0 ([USB-0]).
- When you convert stored data on a USB memory device ([USB-0] or [USB-1])
  A CSV file is saved in the same folder as the stored data file you are converting.

- Data storage may fail under the following circumstances. When this happens, an asterisk appears in the storage state indication. The storage count includes the missing stored data.
  - When you perform consecutive operations in the setup menu.
  - When the WT1800 receives consecutive communication commands.
  - When you operate the WT1800 over FTP.
- If you choose to store data through USB and the write speed of the connected USB device is slow, a new numeric data storage operation may begin before the previous operation is finished, and some of the numeric data may be lost. When this happens, an asterisk appears in the storage state indication. The storage count includes the missing stored data. You can avoid the loss of numeric data during storage by:
  - Setting a longer data update interval.
  - Reducing the number of stored data types.
  - Using a faster USB memory device.
- When it takes a long time for data to be written to the USB, storage may be stopped forcefully, and some data may not be saved. When this happens, the storage state indication is “Error.”
- Conversion to ASCII format (.csv) uses a pair of files that consists of a stored numeric data file (.wts) and a header file (.hds) with the same name. Do not change the names of stored numeric data (.wts) and header (.hds) files for different sets of data to the same name. If you do so, the WT1800 may malfunction and the USB memory may be damaged when you convert the data to ASCII format (.csv).
- If you remove the USB memory during storage and the storage state indication is “Error,” the stored data file may be incomplete or corrupted. If this is the case, you will not be able to convert the data to ASCII format (.csv). Be sure to remove the USB memory after storage has been reset or has completed (Cmpl).
- When you turn off the WT1800 power, the contents of the internal RAM disk are lost. Save the contents of the RAM disk to a USB memory device or network drive before you turn off the WT1800.
- Please be aware that the number of times that you can write to USB memory is limited.

Starting, Stopping, and Resetting Storage (STORE START, STORE STOP, and STORE RESET)

Starting Storage (STORE START)

- When you press STORE START, storage starts under one of the conditions described below, depending on the storage mode.
  - Manual storage mode (Manual)
    Storage starts immediately.
  - Real-time storage mode (Real Time)
    The WT1800 enters into a storage-ready state. Storage starts when the scheduled storage start time is reached.
  - Integration-synchronized storage mode (Integ Sync)
    The WT1800 enters into a storage-ready state. Storage starts when integration starts.
  - Event-synchronized storage mode (Event)
    The WT1800 enters into a storage-ready state. Storage starts when a user-defined event occurs.
  - Single-shot storage mode (Single Shot)
    Storage starts immediately. Numeric data is stored whenever you press STORE START.
- When storage starts, the STORE START key illuminates, and “Store:Start” appears in the upper left of the screen.
- When the WT1800 is in a storage-ready state, the STORE START key blinks, and “Store:Ready” appears in the upper left of the screen.
- After storage is reset, a stored data file (.wts) and header file (.hds) are created when storage starts again.
- When the storage state is “Stop,” you can restart storage. When you restart storage, the stored data continues to be written to the file from before storage was stopped.
- When the store state is “Cmpl,” you cannot restart storage until you reset it. After you reset storage and then start it, a new stored data file is created and written to.

Stopping Storage (STORE STOP)

- You can temporarily stop storage by pressing STORE STOP.
- When storage stops, the STORE STOP key blinks, and “Store:Stop” appears in the upper left of the screen.
- When the storage count is zero and the WT1800 is in a storage-ready state (Ready)* and you press STORE STOP, storage is reset. The storage data file (.wts) and storage header file (.hds) are deleted.

  * This state can occur in real-time storage mode when you have pressed STORE START but the scheduled storage start time has not yet arrived (the storage operation has not begun).

Ending Storage

- Depending on the storage mode, storage automatically stops and the storage state changes to “Cmpl” under one of the following conditions.
  - Manual storage mode (Manual)
    Storage continues until the storage count is reached.
  - Real-time storage mode (Real Time)
    Storage continues until the storage count or the scheduled storage stop time.
  - Integration-synchronized storage mode (Integ Sync)
    Storage continues until the storage count is reached, and then storage is completed (Cmpl). When integration stops, the following occurs.
    - If integration cannot be restarted without being reset, the storage state changes to “Stop.”
    - If integration can be restarted without being reset, the storage state changes to “Ready.”
  - Event-synchronized storage mode (Event)
    Storage continues until the storage count is reached.
  - Single-shot storage mode (Single Shot)
    Storage continues until the storage count is reached.
- After storage is completed, the following occurs.
  - The STORE STOP key illuminates, and “Store:Cmpl” appears in the upper left of the screen.
  - Writing to the stored data file (.wts) and header file (.hds) finishes, and the files are closed.
  - When automatic CSV conversion (Auto CSV Conversion) is enabled, an ASCII format stored data file (.csv) is created.

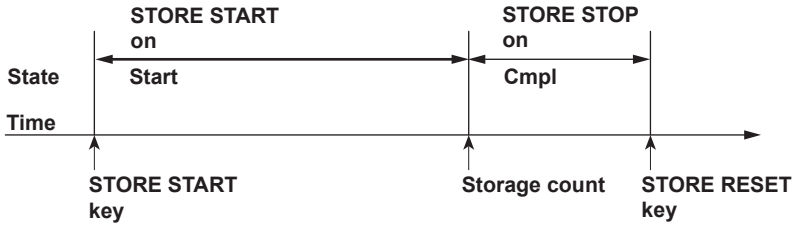
Storage will stop before the specified storage count if the storage destination runs out of available memory or the stored data size exceeds the maximum value (1 GB).

Resetting Storage (STORE RESET)

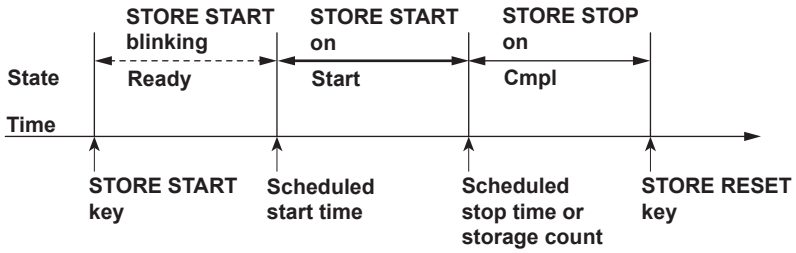
- When you reset storage, the WT1800 enters into the reset store state, in which the store state indicator is blank.
- If you reset storage when the store state is “Stop,” writing to the stored data file (.wts) and header file (.hds) finishes, and the files are closed. When automatic CSV conversion (Auto CSV Conversion) is enabled, an ASCII format stored data file (.csv) is created.
- When the store state is “Cmpl,” the stored data file (.wts) and header file (.hds) are already closed, so no file operations are performed when storage is reset.

Storage Operations in Each Storage Mode

Manual (Manual storage mode)

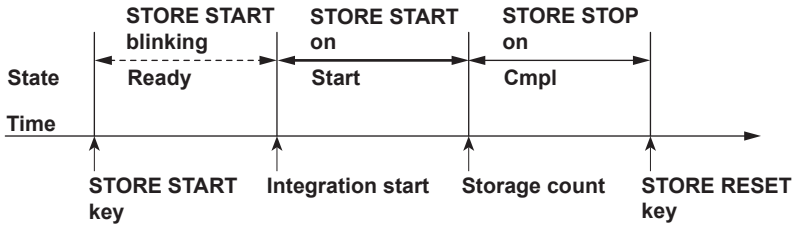


Real Time (Real-time storage mode)

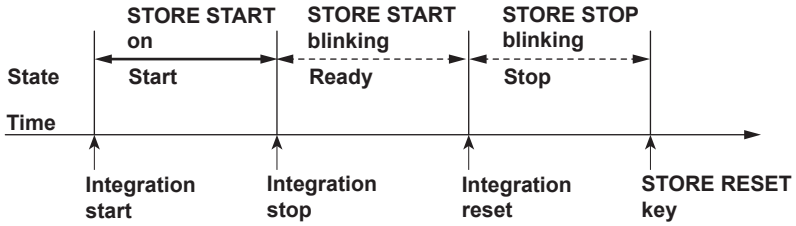


Integ Sync (Integration-synchronized storage mode)

When the storage count is reached before integration stops

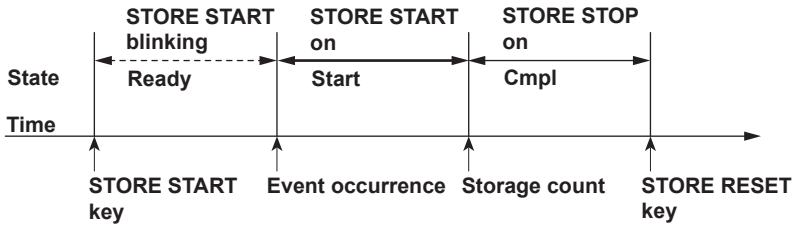


When integration stops before the storage count is reached (illustration of operations after integration starts)

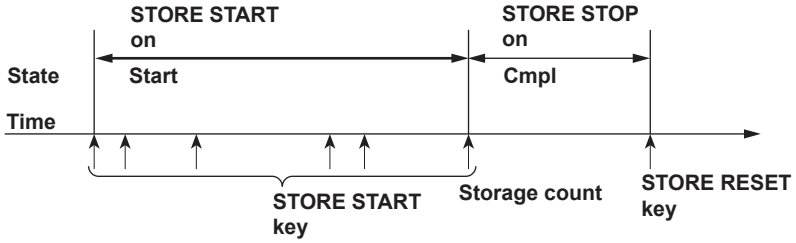


- If you reset integration after it has been stopped, the store state changes to “Cmpl.” Writing to the stored data file (.wts) and header file (.hds) finishes, and the files are closed.
- If you restart integration after it has been stopped, the store state changes to “Start.” The stored data continues to be written to the file from before storage was stopped.

Event (Event-synchronized storage mode)



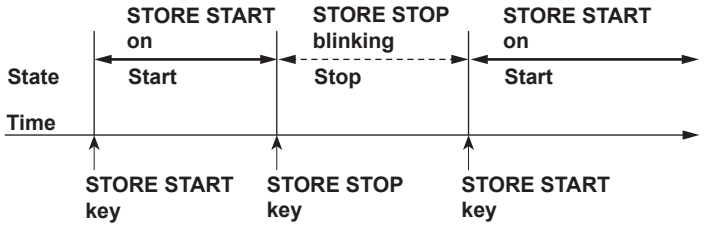
Single Shot (Single-shot storage mode)



Storage Operations Performed When You Press STORE STOP After Storage Has Been Started

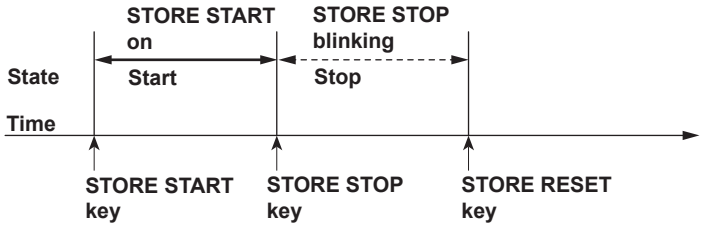
Restarting Storage

When you press STORE START, STORE STOP, and then STORE START



Resetting Storage

When you press STORE START, STORE STOP, and then STORE RESET

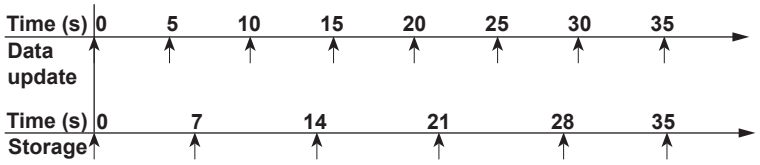


Storage Operation When the Storage Interval Is Not an Integer Multiple of the Data Update Interval

Here we will use the case when the data update interval is 5 s and the storage interval is 7 s as an example. How storage is performed varies as indicated below depending on the storage mode.

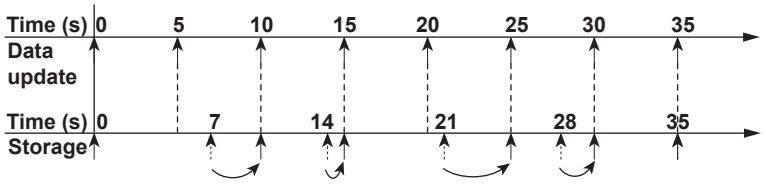
When the Storage Mode Is Not Set to Integ Sync

Storage is performed according to the storage interval.



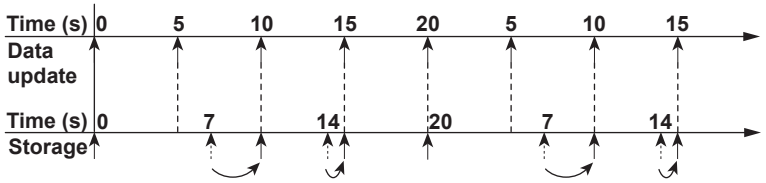
When the Storage Mode Is Integ Sync and the Integration Mode Is Not Continuous or R-Continuous

Storage is performed at the first data update after the storage interval passes.



When the Storage Mode Is Integ Sync and the Integration Mode Is Continuous or R-Continuous

Storage is performed at the first data update after the storage interval passes. Storage continues even when integration is reset by the integration timer. When the integration timer is reset, the storage interval timer is also reset. The figure below is an example for when the integration timer is set to 20 s.



- When the storage of numeric data at store start (Store At Start) is enabled, storage starts when the time is at 0 s (store start).
- Storage is performed when the integration mode is continuous integration mode or real-time continuous integration mode, the integration timer time elapses, and the integrated values are reset. In the above example, the integration timer is set to 20 s, so the data is stored after 20 s have passed, and then the integrated values are reset.

Operations when Values Are Held

If you press HOLD after storage has been started, the displayed values are held, and storage is performed as indicated below.

- When the storage mode is set to Manual and the storage interval is 00:00:00, when the storage mode is set to Real Time and the storage interval is 00:00:00, or when Storage Mode is set to Event
  The storage operation stops, but integration does not.
- When the storage mode is set to Single Shot
  The held display values are stored. Even during integration, the held display values are stored.
- In All Other Cases
  The held display values are stored. During integration, the values being measured are stored.

- Media access indication icon only illuminates when the WT1800 creates files at the start of storage and closes them at the end of storage, but the WT1800 is actually always accessing the storage medium. During the period between when the files are created and when they are closed, do not remove the USB memory or turn off the power. Doing so may damage the storage medium and corrupt its data.
- When a point has no numeric data, NAN, OL, OF, ERROR, or a blank space will be stored instead. The places that contain blank spaces are in measurement functions such as the ones for the 0th (DC) and 1st harmonic orders of ΦU and ΦI, where the screen display is also blank.
- Functions ΔU1 to ΔPΣ are stored according to the delta computation (option) type that you selected in the delta computation settings.
- When the WT1800 automatically changes the range during storage, because measured data cannot be acquired, the store operation is paused and no measured data is stored. After the WT1800 finishes changing the range, storage resumes.
- You cannot use the auto print feature during storage.

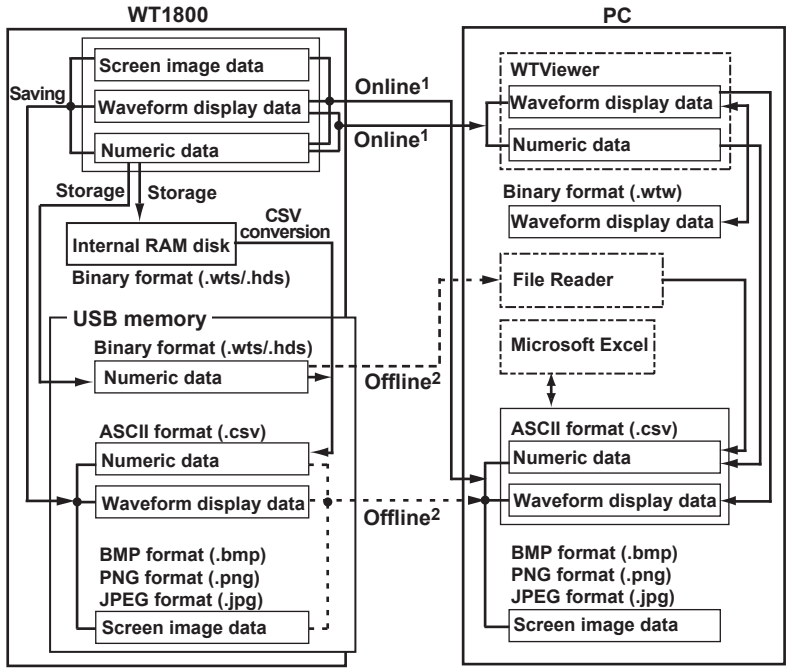
18 Saving and Loading Data

You can save numeric data, waveform display data, screen image data, and setup parameters to USB memory or a network drive.
For information about saving screen image data, see “Saving Screen Images”

▶ Click here.

You can load the setup data from a storage medium into the WT1800.
You can also rename, copy, and delete data files.

Using a PC to Load Numeric Data, Waveform Display Data, or Screen Image Data



1 Data acquisition using USB, Ethernet, or GP-IB
2 Data acquisition using USB memory

Storage Media

The WT1800 can access the following three types of storage media for saving and loading data.

Internal RAM Disk (RAM-0)

The internal RAM disk of the WT1800.

USB Memory (USB-0 or USB-1)

A USB memory device that is connected to the WT1800 USB port. USB2.0 mass storage devices compatible with USB Mass Storage Class Ver. 1.1 can be connected to the WT1800.

Network Drive (Network)

A storage device on the network. You can use a network storage device by connecting the WT1800 to an Ethernet network.

When you turn off the WT1800 power, the contents of the internal RAM disk are lost. Save the contents of the RAM disk to a USB memory device or network drive before you turn off the WT1800.

Notes about Using USB Devices

- Connect the USB memory device to the USB port for peripherals (type A) directly, not through a USB hub.
- Use portable USB storage media that are compatible with USB Mass Storage Class version 1.1.
- You cannot use protected USB storage devices (such as those that contain encrypted content).
- Only connect compatible USB keyboards, mouse devices, or memory devices to the USB ports for peripherals.
- Do not connect and disconnect multiple USB devices repetitively. Provide a 10-second interval between removal and connection.
- Do not connect or remove USB devices from the time when the WT1800 is turned on until key operation becomes available (approximately 20 to 30 seconds).
- The WT1800 can handle up to two USB memory devices.

Saving Setup Data (Save Setup)

You can save the WT1800 setup data to the specified storage medium. The date, time, and communication setup parameters are not saved.
The extension is .SET.
For information about the file save conditions, see “File Save Conditions.”
▶ **Click here.**

Saving Waveform Display Data (Save Wave)

You can save the waveform data that the WT1800 has measured to a file in ASCII format (.csv). The waveform displayed on the screen is saved.
For information about the file save conditions, see “File Save Conditions.”
▶ **Click here.**

The waveform display data that the WT1800 saves is not the sampled waveform data that is acquired at the WT1800 sample rate (of approximately 2 MS/s). The WT1800 performs P-P compression on the sampled waveform data, to produce 1602 points of waveform display data that are used to display the waveform on the screen.

Saving Numeric Data (Save Numeric)

You can save the numeric data that the WT1800 has measured to a file in ASCII format (.csv).
For information about the file save conditions, see “File Save Conditions.”
▶ **Click here.**

When you save numeric data and a point has no numeric data, NAN, OL, OF, ERROR, or a blank space will be saved instead. The places that contain blank spaces are in measurement functions such as the ones for the 0th (DC) and 1st harmonic orders of ΦU and ΦI, where the screen display is also blank.

File Save Conditions

Displaying a File List and Specifying the Save Destination (File List)

On the file list, specify the save destination. For information about how to configure the file list display and how to operate files and folders, see “File Operations (Utility).”

▶ Click here.

Saved Items (Item Settings)

This menu item only appears when you select Save Numeric.

Displayed Numeric Items (Displayed Numeric Items)

The saved items vary as indicated below depending on the display.

- When Numeric Values Are Displayed in the 4-, 8-, or 16-Value Display or the Matrix Display
  All the measurement functions on the page that is displayed when saving starts are saved in the order that they are displayed.
- When Numeric Values Are Displayed in the Single or Dual Harmonics List
  In addition to the data described above, the data of harmonics that are not displayed on the screen is saved up to the maximum measurable order (Max Order).
- When Numeric Values Are Displayed in the All Items or Custom Display
  The data cannot be saved. If you attempt to save the data, an error message is displayed.
- In Non-Numeric Displays (Waveform display, trend display, etc.)
  The WT1800 saved data according to the numeric display settings. For example, when the waveform display is shown, if the 16-value display would appear when you pressed NUMERIC, then the data for the measurement functions on the page of the 16-value display that would appear is saved.

Selected Items (Selected Items)

You can select the types of numeric data to save.

Items (Items)

If you selected Selected Items, select which numeric data to save.

- **Element (Element)**
  To select an element or wiring unit that you want to store the data of, select or clear its check box. You can select from the following options.
  Element1, Element2, Element3, Element4, Element5, Element6, ΣA, ΣB, and ΣC
- **Function (Function)**
  Select whether to store the data of a function by selecting or clearing its check box. You can select any of the measurement function types listed under “Items That This Instrument Can Measure.”
  ▶ Click here.
- **Selecting All Functions (All ON)**
  The data of all measurement functions is saved.
- **Deselecting All Functions (All OFF)**
  None of the data for any of the measurement functions is saved.
- **Preset 1 (Preset 1)**
  The data of the following measurement functions is saved for all elements and wiring units.*
  Urms, Irms, FreqU, FreqI, P, S, Q, λ, and Φ
- **Preset 2 (Preset 2)**
  The data of the following measurement functions is saved for all elements and wiring units.*
  WP, WP+, WP–, q, q+, q–, Time, WS, and WQ

* If the wiring system setting (Wiring) is configured so that a wiring unit does not exist, the data for the functions of that wiring unit is not saved. For example, if ΣC does not exist, the data for ΣC is not saved.

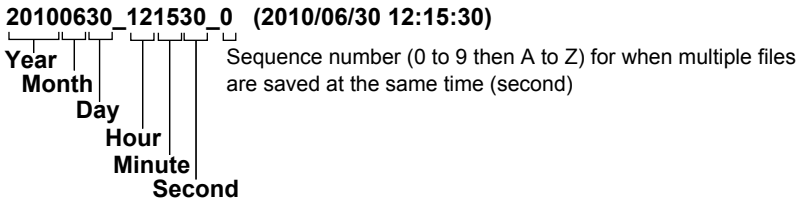
Automatic File Naming (Auto Naming)

Numbering (Numbering)

The WT1800 automatically adds a four-digit number from 0000 to 0999 after the common name specified using the File Name setting and saves files.

Date (Date)

The date and time when the file is saved are used as its name. The file name specified for the File Name setting is ignored.



A sequence number is appended to the date and time when multiple files are saved at the same time (second). The number starts at 0 and is incremented by one each time a file is added. The number 9 is followed by letters of the alphabet.

OFF

Disables the auto naming feature. The name that you specify using the File Name setting is used. If there is a file with the same name in the save destination folder, you cannot save the data.

Save Destination Folder for Storage Caused by User-Defined Events

In the drive specified in the Store Set menu, a folder is automatically created with the date (year, month, and day) as its name, and data is saved to files in that folder whose names are specified by the auto naming feature. If the number of files in the save destination folder exceeds 1000, a new folder is automatically created with the date and an incremented sequence number (000 to 999) as its name, and the data continues to be saved in the new folder.

File Name (File Name)

You can set the common file name that is used when the auto naming feature is turned off or when the auto naming feature is set to Numbering. The maximum number of characters that you can use for file names and folder names is 32 characters. The following restrictions apply.

- The following types of characters can be used: 0 to 9, A to Z, a to z, _, –, =, (,), {, }, [,], #, $, %, &, ~, !, `,and @. @ cannot be entered consecutively.
- The following character strings cannot be used due to MS-DOS limitations.
  AUX, CON, PRN, NUL, CLOCK, LPT1, LPT2, LPT3, LPT4, LPT5, LPT6, LPT7, LPT8, LPT9, COM1, COM2, COM3, COM4, COM5, COM6, COM7, COM8, and COM9
- Make sure that the full file path (absolute path from the root directory) is less than or equal to 255 characters in length. If it exceeds 255 characters, an error occurs when you perform a file operation (such as save, copy, rename, or create folder). When an operation is being performed on a folder, the full path is up to the name of the folder. When an operation is being performed on a file, the full path is up to the name of the file.

The following additional restrictions apply when you use the file name auto naming feature.

- If you set auto naming to Numbering, a file name will consist of the characters that you entered for the file name and a four-character sequence number.
- If you set auto naming to Date (date and time), the characters that you entered for the file name will not be used. File names will only consist of the date information.

Comment (Comment)

You can add a comment that consists of up to 30 characters when saving files. You do not have to enter a comment. In the comment, you can include spaces and all characters that are displayed on the keyboard. The comment appears in the bottom of the screen.

Settings That Are Shared with Those of Other Menus

The following settings are shared by the menus for saving the custom display configuration, storing data, saving and loading data, and saving screen images.

- File list display and save destination settings (File List)
- Automatic file naming settings (Auto Naming)
- File name (File Name)

The comment settings (Comment) are shared by the menus for storing data, saving and loading data, saving screen images, and the menus for printing screen images and numeric data.

Saving (Save Exec)

Saves the data to the specified save destination with the specified file name.

- It can take anywhere from a few seconds to a few tens of seconds for the WT1800 to save the data, depending on the number of waveforms being saved, the data update interval, and the transfer speed to the save destination medium. It will take longer for the WT1800 to save the data when there many waveforms are saved or the data update interval is long.
- Measurement stops while the WT1800 is saving data. After the WT1800 finishes saving or saving is cancelled, measurement resumes.
- To save data when the data update interval is 20 s, enable the hold feature, perform a single-shot measurement, and then save the data after the data update for the single-shot measurement has completed.

Because the header files saved by the WT1800 use a format that is common to YOKOGAWA measurement devices, they contain some data that is not used by the WT1800.

Loading Setup Data (Load Setup)

On the file list, specify a file to load setup data from. The extension is .SET. For information about how to configure the file list display and how to operate files and folders, see “File Operations (Utility).”

▶ **Click here.**

Loading (Load Exec)

Loads the data of the specified file.

- If you change the extension of the saved data file, by using a PC or some other device, the WT1800 will no longer be able to load it.
- When setup information is loaded from a file, the setup data for each key is changed to match the loaded settings, and it cannot be changed back. We recommend that you save the current settings before loading different setup information.
- The date, time, and communication setup parameters are not saved. So even if you load setup parameters from a file, the date, time, and communication settings will not change.
- The WT1800 cannot load setup parameters that have been saved by a product with an incompatible firmware version.
- The WT1800 cannot load setup parameters that were saved by an instrument with a different element configuration, different options, etc.

File Operations (Utility)

You can perform file operations such as creating folders on the storage medium, deleting and copying files, and changing file names.

Us the up and down cursor keys to select from the file list the file or folder that you want to perform an operation on.

Storage Media Displayed in the File List

▶ Click here.

- Up to 512 files and folders can be displayed in the file list. If there are more than a total of 512 files and folders in a given folder, the file list for that folder will only display 512 files and folders. There is no way to set which files and folders are displayed.
- When you turn off the WT1800 power, the contents of the internal RAM disk are lost. Save the contents of the RAM disk to a USB memory device or network drive before you turn off the WT1800.

Sorting the File List (Sort To)

You can sort the file list by file name, size, or date and time.

Display Format

Select whether to display a list of files or to display thumbnails.

Selecting the Type of File to List (File Filter)

You can limit the type of files that appear in the list by selecting an extension.

Changing the Storage Medium (Change Drive)

You can select the storage medium that you want to access. The WT1800 displays the storage media as follows:

- RAM-0: The internal RAM disk of the WT1800
- USB-0: The first USB memory device connected to a WT1800 USB port
- USB-1: The second USB memory device connected to a WT1800 USB port
- Network: A storage device on the network

Deleting Files and Folders (Delete)

You can delete the selected files and folders.

Renaming Files and Folders (Rename)

You can rename a selected file or folder.

Making Folders (Make Dir)

Make a folder. You can use the same characters in folder names that you can in file names.

Copying and Moving Files and Folders (Copy and Move)

You can copy or move the selected files and folders to other storage media or folders. You can copy or move multiple files at the same time.

Operations (Operation)

You can select from the following operations.

- Delete: Delete files and folders.
- Rename: Rename a file or folder
- Make Dir: Make a folder
- Copy: Copy files and folders
- Move: Move files and folders

File Selection (Set/Reset)

Select or deselect files and folders. Selecting multiple files is useful when you want to copy or delete multiple files at the same time.

Simultaneous File Selection (All Set/All Reset)

- **Selecting All Files (ALL Set)**

  When the cursor is on a drive or folder in the file list, select ALL Set to select all of the files and folders within the drive or folder that the cursor is on.
- **Deselecting All Files (ALL Reset)**

  All of the selected files and folders are deselected.

Jumping to a Specified File or Folder (Jump To)

You can make the cursor jump to a file or folder at a specified numeric position in the file list. The numeric position at the top of the file list is 0.

Range: 0 to 999

Other Operations (More...)

You can select from the following operations.

- Sort To: Sort the file list.
- Display Type: Select the display format (list or thumbnail).
- Filter: Select the type of file to list.
- Change Drive: Change the storage medium.

Executing an Operation

Execute the operation that you specified for the Operation setting.

19 Saving Screen Images

You can save screen image data to files in BMP, PNG, and JPEG formats.

Conditions for Saving Screen Image Data (IMAGE SAVE MENU)

File List Display and Save Destination Settings (File List)

On the file list, specify the save destination. For information about how to configure the file list display and how to operate files and folders, see “File Operations (Utility).”

▶ Click here.

When you turn off the WT1800 power, the contents of the internal RAM disk are lost. Save the contents of the RAM disk to a USB memory device or network drive before you turn off the WT1800.

Format of Screen Image Data (Format)

You can select the format to save to from the options listed below.

- BMP: The extension is .BMP. The file size is approximately 100 KB for black and white mode and approximately 1.5 MB for color mode.
- PNG: The extension is .PNG. The file size is approximately 25 KB for black and white mode and approximately 100 KB for color mode.
- JPEG: The extension is .JPG. The file size is approximately 200 KB for color mode.

The file sizes listed here are for reference. Actual file sizes will vary depending on the image that is saved.

Screen Image Colors (Color)

You can select the color format to save to from the options below.

- OFF: Data is saved in black and white.
- Color: Data is saved in 65536 colors.
- Reverse: Data is saved in 65536 colors. The image background is set to white.
- Gray: Data is saved in 16 grayscale levels.

Automatic File Naming (Auto Naming)

This is the same as the auto naming feature for saving and loading data.

▶ Click here.

File Name (File Name)

This is the same as the file name setting for saving and loading data.

▶ Click here.

Comment Displayed at the Bottom of the Screen (Comment)

This is the same as the comment setting for saving and loading data.

▶ Click here.

Saving a Screen Image (IMAGE SAVE)

Save the screen image to a file.

20 Printing Screen Images and Numeric Data (Option)

You can use the built-in printer to print screen images and numeric data lists. You can also add comments to screen images.
If you use automatic printing, screen images and numeric data lists are printed automatically at the specified print interval. Also, you can set scheduled automatic printing start and stop times to print at a specific time.

Printing Conditions (PRINT MENU)

You can configure the following printing conditions.

- Output format (Format)
- Automatic printing execution (Auto Print ON)
- Automatic printing (Auto Print Settings)
- Comment (Comment)
- Paper feed (Paper Feed)

Output Format (Format)

You can select the data format to print from the options listed below.

- Screen: Screen image data
- List: Numeric list data

Printed Items

If you set the output format to numeric data list (List), the printed items vary as indicated below depending on the display that is shown.

- When numeric values are displayed in the 4-, 8-, or 16-value display or the matrix display
  All the measurement functions on the page that is displayed when printing starts are printed in the order that they are displayed.
- When numeric values are displayed in the single or dual harmonics list
  In addition to the data described above, the data of harmonics that are not displayed on the screen is printed up to the maximum measurable order (Max Order).
- When numeric values are displayed in the All Items or Custom display
  Printing cannot be performed. If you attempt to print the data, an error message is displayed.
- In non-numeric displays (waveform display, trend display, etc.)
  The WT1800 prints data according to the numeric display settings. For example, when the waveform display is shown, if the 16-value display would appear when you pressed NUMERIC, then the data for the measurement functions on the page of the 16-value display that would appear is printed.

- For items with no numeric data, “-------” (no data) is printed.
- If integration is not being performed and thus there is no integrated value, “-------” (no data) is printed. “-------” (no data) is also printed for the integration time.
- The maximum harmonic order that can be printed is determined by the maximum harmonic order set in the harmonic measurement (option) menu. For orders with no numeric data, “-------” (no data) is printed.
- Functions ΔU1 to ΔPΣ are printed according to the delta computation (option) type that you selected in the delta computation settings.

Automatic Printing Execution (Auto Print ON)

Enable automatic printing. When you enable automatic printing, the timing at which printing occurs and at which the PRINT key illuminates varied depending on the print mode. For details, see “Print Timing for Different Print Modes.”

▶ Click here.

Limitations on Changing the Settings during Automatic Printing

While automatic printing is enabled, there are some setting that you cannot change and functions that you cannot execute. For details, see appendix 9 in the getting started guide, IM WT1801-03EN.

If you perform the following operations while automatic printing is enabled, automatic printing will not be performed.

- Save data or settings or access a storage medium in some other way
- Execute an FTP server command
- Manually start printing or start printing using communication commands

Automatic Printing (Auto Print Settings)

Print Mode (Print Mode)

You can specify the method for starting, stopping, and executing printing from the options below.

- **Interval: Interval Print Mode**
  Printing starts when you enable automatic printing. Data is printed at each print interval.
- **Real Time: Real-Time Print Mode**
  Printing starts and stops in synch with the scheduled printing start and stop times. Data is printed at each print interval.
- **Integ Sync: Integration Synchronization Print Mode**
  Printing starts and stops in synch with the starting and stopping of integration. Data is printed at each print interval.
- **Event: Event Synchronization Print Mode**
  When you enable automatic printing, printing is executed when the measurement data is updated and a user-defined event occurs. Printing is executed at the data update interval for as long as the event continues. However, if the time it takes to print is longer than the data update interval, after printing stops, it starts again at the next data update.

Print Count (Print Count)

This setting is valid when Print Mode is set to Interval, Real Time, or Event.
You can set the print count within the following range.
Infinite, or 1 to 9999

Print Interval (Print Interval)

This setting is valid when Print Mode is set to Interval, Real Time, or Integ Sync.
You can set print interval hour, minute, and second within the following range.
00:00:10 to 99:59:59
When the print interval is not an integer multiple of the data update interval, the print operation behaves in the same manner described in “Storage Operation When the Storage Interval Is Not an Integer Multiple of the Data Update Interval.”

▶ Click here.

- If you specify a number of measurement functions as items to be printed, it may take a long time to print the data. Set the print interval to a time that is longer than the time required to print the data.
- If you touch the keys or execute communication commands during printing, printing may slow down.

Scheduled Start and Stop Times (Real Time Control)

You can configure these settings when Print Mode is set to Real Time. You can set the year, month, day, hour, minute, and second of the print start and stop times. Be sure to set the scheduled printing stop time to a time after the printing start time.

You can set the values within the following ranges.

- Year: Any four-digit Gregorian calendar value
- Hour:Minute:Second: 00:00:00 to 23:59:59
- Now: The scheduled printing start time is set to the current time.
- Copy: The scheduled printing start time is copied into the scheduled printing stop time.

- You can set the day for the scheduled start or stop time in February to a value as high as the 31st day. If you do so, an error message will appear when you enable automatic printing. Reset the scheduled start and stop times.
- The WT1800 recognizes leap years when it executes automatic printing.

Trigger Event (Trigger Event)

You can configure this setting when Print Mode is set to Event. You can select an event from Event1 to Event8. Printing is executed whenever the user-defined event specified here occurs.

Printing of the Data at Print Start (Print At Start)

This setting is valid when Print Mode is set to Interval, Real Time, or Integ Sync.

Select whether to print the data at print start.

Comment (Comment)

This is the same as the comment setting for saving and loading data.

▶ **Click here.**

Paper Feed (Paper Feed)

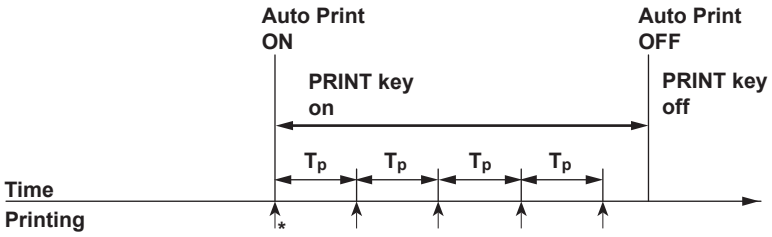
Each time you press Paper Feed, the paper roll is fed through by approximately 3 cm.

Print Timing for Different Print Modes

The timings at which automatic printing can be executed are indicated below.

Interval Print Mode

When the scheduled start time is before Auto Print ON

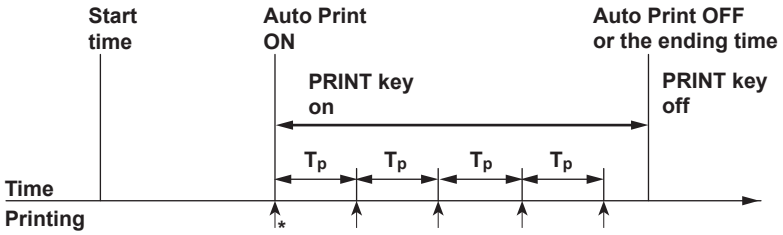


Tp: Print interval

*** Data is printed if Print at Start is set to ON.**

Real-Time Print Mode

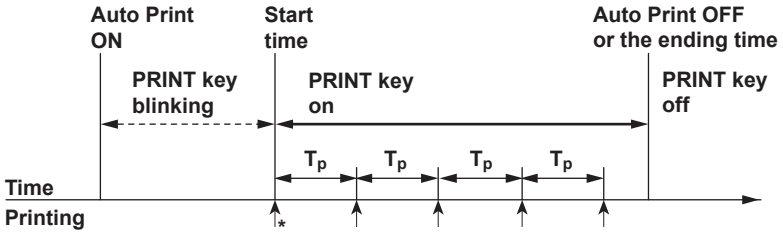
When the scheduled start time is before Auto Print ON



Tp: Print interval

*** Data is printed if Print at Start is set to ON.**

When the scheduled start time is after Auto Print ON



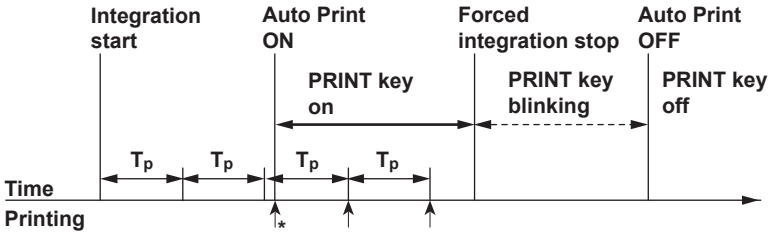
Tp: Print interval

*** Data is printed if Print at Start is set to ON.**

Integration Synchronization Print Mode

Printing is executed in sync with the integration start time.

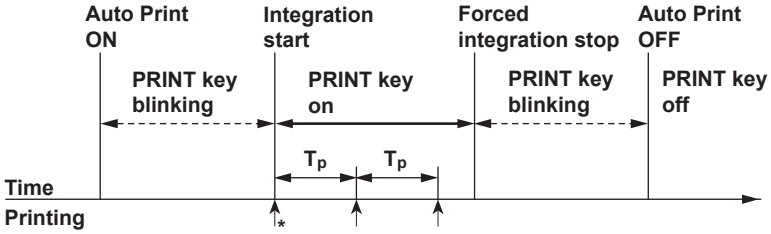
When integration starts before Auto Print ON



Tp: Print interval

* Data is printed if Print at Start is set to ON.

When integration starts after Auto Print ON

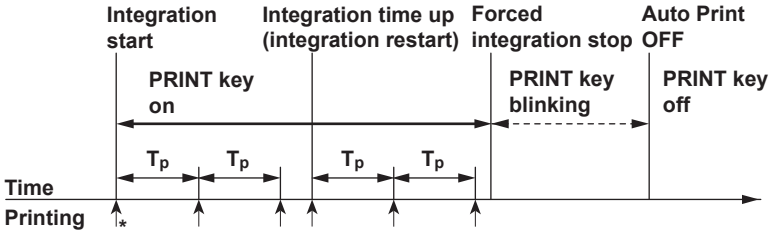


Tp: Print interval

* Data is printed if Print at Start is set to ON.

Integration Timer and Print Interval in Continuous Integration Mode and Real-Time Continuous Integration Mode

Printing is executed whenever the integration timer time elapses.



Tp: Print interval

* Data is printed if Print at Start is set to ON.

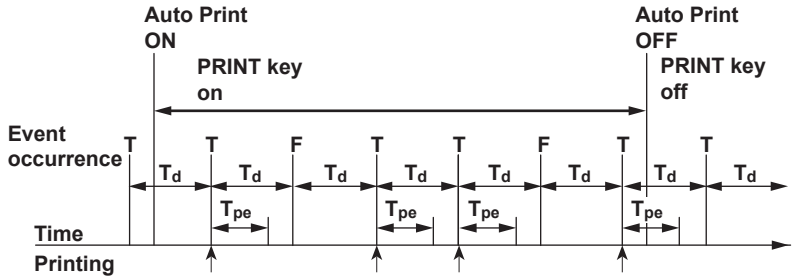
If integration stops for one of the following reasons, printing is executed, and Auto Print is automatically set to OFF.

- The integration timer time elapses: TimeUp
- The scheduled stop time is reached: Stop (in orange text)

Event Synchronization Print Mode

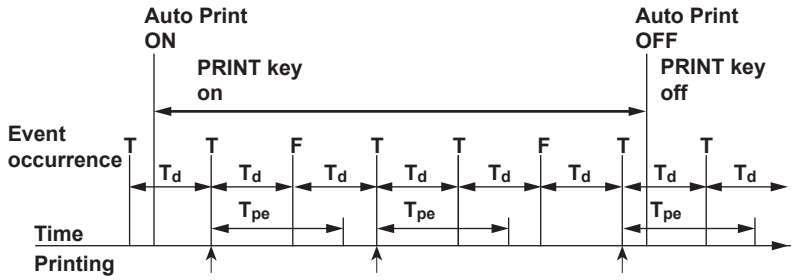
Printing is executed whenever a user-defined event occurs.

When the time it takes to print is shorter than the data update interval



T: Event occurrence
F: No event occurrence
Td: Data update interval
Tpe: Time it takes to print

When the time it takes to print is longer than the data update interval



T: Event occurrence
F: No event occurrence
Td: Data update interval
Tpe: Time it takes to print

Printing (PRINT)

Prints the screen image data or numeric data list.

Using an External Signal to Control Printing (Option)

On models with the 20-channel D/A output option, you can use the remote control feature to print data. For details about the remote control feature, see appendix 4.6 in the getting started guide, IM WT1801-03EN.

21 Ethernet Communication (Network)

You can configure TCP/IP parameters and use the optional Ethernet interface to perform the following tasks.

TCP/IP

TCP/IP settings for connecting to an Ethernet network.
Set the IP address, subnet mask, and default gateway.

▶ **Click here.**

FTP Server (FTP Server)

You can connect the WT1800 as an FTP server to a network.
You can connect to the WT1800 from a PC on the same network and retrieve setup data, numeric data, waveform display data, and screen image data.

▶ **Click here.**

Network Drive (Net Drive)

You can save the WT1800's setup data, numeric data, waveform display data, and screen image data to a network drive. You can also load the setup data from a network drive into the WT1800.

▶ **Click here.**

SNTP

The WT1800 clock can be set using SNTP. When the WT1800 is turned on, the date and time are set automatically.

▶ **Click here.**

To connect a PC to the WT1800, use a hub or router, and connect to a network. Do not connect a PC directly to the WT1800.

TCP/IP (TCP/IP)

Configure the settings that the WT1800 needs to connect to a network.

DHCP

DHCP is a protocol that temporarily allocates settings that a PC needs to connect to the Internet.
To connect to a network that has a DHCP server, turn the DHCP setting on. When DHCP is turned on, the IP address can be automatically obtained when the WT1800 is connected to a network. (You do not have to set it manually.)
When DHCP is turned off, you must set the appropriate IP address, subnet mask, and default gateway for the network.

DNS

DNS is a system used to associate Internet host names and domain names with IP addresses. Given AAA.BBBBB.com, AAA is the host name and BBBBB.com is the domain name. You can use host names and domain names to access the network instead of using IP addresses, which are just numbers. The WT1800 allows you to specify the host by name, instead of by IP address. Set the domain name and the DNS server address (0.0.0.0 by default). For details, consult your network administrator.

DNS Servers (DNS Server1/DNS Server2)

You can specify up to two DNS server addresses: primary and secondary. If querying fails with the primary DNS server, the secondary DNS server is automatically used to find the mapping of the host name and domain name to the IP address.

Domain Suffixes (Domain Suffix1/Domain Suffix2)

The domain suffix is a piece of information that is automatically added when a query is made to a DNS server using only a portion of the domain name. For example, if BBBBB.co.jp is registered as a domain suffix and a query is made using “AAA,” the name “AAA.BBBBB.co.jp” is searched.
You can specify up to two domain suffixes: Domain Suffix1 and Domain Suffix 2.
You can use up to 127 characters. The characters that you can use are 0 to 9, A to Z, a to z, and hyphens.

TCP/IP settings are applied when you press Bind and then SET or when you turn on the WT1800 the next time.

FTP Server (FTP Server)

You can connect the WT1800 as an FTP server to a network.
Set the user name and password that will be used by devices on the network to access the WT1800. Also, set the access timeout value.

User Name (User Name)

Set the user name that will be used to access the WT1800 from a PC. If you set the user name to “anonymous,” you can connect to the WT1800 without entering a password.

- Number of characters: Up to 32
- Usable characters: All ASCII characters that are displayed on the keyboard

Password (Password)

Set the password that will be used to access the WT1800 from a PC.

- Number of characters: Up to 32
- Usable characters: All ASCII characters that are displayed on the keyboard

Timeout (Time Out)

If an FTP connection cannot be established between the WT1800 and the PC within the amount of time specified here, the WT1800 aborts the connection process.
You can set the timeout time to a value between 1 and 3600.

To apply the settings that you specified, press Entry.

FTP Server Overview

When the WT1800 is connected to the network as an FTP server, the following features become available.

FTP Server Feature

From a PC, you can view a list of files that are stored in the WT1800 storage media (the internal RAM disk and the storage media that are connected to the WT1800) and retrieve files.

Network Drive (Net Drive)

You can save the WT1800's setup data, numeric data, waveform display data, and screen image data to a network drive. You can also load the setup data from a network drive into the WT1800.

FTP Server (FTP Server)

Specify the IP address of an FTP server on the network. You can save numeric data, waveform display data, and screen image data to the server and load setup data from it. In a network with a DNS server, you can specify the host name and domain name instead of the IP address.

Login Name (Login Name)

Specify the login name.

- Number of characters: Up to 32
- Usable characters: All ASCII characters that are displayed on the keyboard

Password (Password)

Specify the password that corresponds to the login name.

- Number of characters: Up to 32
- Usable characters: All ASCII characters that are displayed on the keyboard

Passive Mode (Passive)

Turn passive FTP on or off.
In passive mode, the FTP client sets the port number for data transfer. Enable passive mode when you have set an external FTP server as a network drive or when you are accessing an FTP server through a firewall.

Timeout (Time Out)

If the WT1800 cannot transfer files for a certain amount of time, it disconnects from the FTP server.
You can set the timeout time to a value between 1 and 3600.

Connecting to the Network Drive(Connect/Disconnect)

When you press Connect, the WT1800 connects to the specified network drive. When you press Disconnect, the network drive is disconnected.

SNTP (SNTP)

The WT1800 clock can be set using Simple Network Time Protocol (SNTP). When the WT1800 is turned on, the date and time are set automatically.

SNTP Server (SNTP Server)

Specify the IP address of the SNTP server that the WT1800 will use. In a network with a DNS server, you can specify the host name and domain name instead of the IP address.

Timeout (Time Out)

If the WT1800 cannot connect to the SNTP server for a certain amount of time, it aborts the operation.
You can set the timeout time to a value between 1 and 60.

Executing Time Adjustment (Adjust)

The WT1800 clock is synchronized to the SNTP server clock.

Automatic Adjustment (Adjust at Power ON)

You can configure the WT1800 so that its clock is automatically synchronized to the SNTP server clock when the WT1800 is turned on when it is connected to the network.

Setting the Time Difference from Greenwich Mean Time (Time Difference From GMT)

This is the same as the “Setting the Time Difference from Greenwich Mean Time (Time Difference From GMT)” setting in the date and time settings.

▶ **Click here.**

The Time Difference From GMT setting is shared with the same setting found in the SNTP settings in the date and time settings (Date/Time). If you change this setting in the Ethernet communication (Network) settings, the Time Difference From GMT in the date and time settings (Date/Time) also changes.

22 Utility

Utility (UTILITY)

You can specify the following settings.

Overview (System Overview)

You can view the WT1800 system and setup information.

▶ Click here.

Initializing the Settings (Initialize Settings)

You can reset the WT1800 settings to their factory default values.

▶ Click here.

Remote Control (Remote Control)

You can select the method for connecting a PC to the WT1800 to control it.

▶ Click here.

System Configuration (System Config)

You can set the date and time, time synchronization, the menu and message languages, the LCD intensity, whether the backlight is on or off, the USB keyboard language, and USB communication, and you can format storage media.

▶ Click here.

Ethernet Communication (Network)

You can configure TCP/IP, FTP server, network drive, and SNTP settings.

▶ Click here.

D/A Output (D/A Output Items; option)

Configure D/A output.

▶ Click here.

Self-Test (Selftest)

You can test the keyboard and memory operations.

▶ Click here.

Overview (System Overview)

You can display the following information about the WT1800.

Item	Description
Model	The model number
Suffix	The suffix code
No.	The instrument number
Version	The firmware version
Element Configuration	The input element type
Options	The options
Link Date	The firmware date
Product ID	A unique device ID that is assigned to each unit (This number is necessary for the purchase of additional options.)

Firmware Version and New Features

This manual covers firmware versions 2.01 or later of the WT1800. The following table contains new features that are available for each firmware version. If you are using an older version, you will not be able to use all the features described in this manual. To view the firmware version, press UTILITY and then the System Overview soft key and check Version on the System Overview screen that is displayed.

Version	Suffix Code	New Features
2.01 or later	/HS	**High Speed Data Capturing features**
		Chinese and German have been added to the menu language and message language.

Initializing the Settings (Initialize Settings)

You can reset the WT1800 settings to their factory default values. This feature is useful when you want to cancel all of the settings that you have entered or when you want to redo measurement from scratch.

Only initialize the WT1800 if you are sure that it is okay for all of the settings to return to their initial values. You cannot undo an initialization. We recommend that you save the setup parameters before initializing the WT1800.

Items That Cannot Be Reset

The following settings cannot be reset.
Date and time settings, communication settings, the menu language setting, the message language setting, and environment settings

To Reset All Settings to Their Default Values

While holding down RESET, turn the power switch on. All settings except the date and time settings (display on/off setting will be reset) will be reset to their factory default values.

Remote Control (Remote Control)

Communication interface for controlling the WT1800 from a PC. GP-IB, USB, and Network are the available communication interfaces.
For details, see the communication interface user's manual, IM WT1801-17EN.

- Only use one communication interface: GP-IB, USB, or Network. If you send commands simultaneously from more than one communication interface, the WT1800 will not execute the commands properly.
- When the WT1800 is in remote mode and is communicating with a PC, "REMOTE" appears in the center of the WT1800 screen. All keys except LOCAL are disabled in Remote mode.

GP-IB

Connects the WT1800 to a PC using GP-IB.

Address (Address)

- You can select a value between 0 and 30.
- Each device that is connected by GP-IB has its own unique address in the GP-IB system. This address is used to distinguish one device from other devices. Therefore, you must assign a unique address to the WT1800 when connecting it to a PC or other device.

When the controller is communicating with the WT1800 or with other devices through GP-IB, do not change the address.

Notes about Connections

- Several cables can be used to connect multiple devices. However, no more than 15 devices, including the controller, can be connected on a single bus.
- When connecting multiple devices, you must assign a unique address to each device.
- Use cables that are 2 m or shorter in length to connect devices.
- Keep the total length of the cables under 20 m.
- When devices are communicating, have at least two-thirds of the devices on the bus turned on.
- To connect multiple devices, use a star or daisy-chain configuration. Loop and parallel configurations are not allowed.

USB

Connects the WT1800 to a PC using USB.
To remotely control the WT1800 using communication commands through the USB port, select USBTMC, and then carry out the following procedure.

- Install the YOKOGAWA USB TMC (Test and Measurement Class) driver on your PC. For information about how to obtain the YOKOGAWA USB TMC driver, contact your nearest YOKOGAWA dealer. You can also access the YOKOGAWA USB driver download webpage and download the driver (http://tmi.yokogawa.com/service-support/downloads/).
- Do not use USB TMC drivers (or software) supplied by other companies.

Network

Connects the WT1800 to a PC using Ethernet.

IP Address (IP Address)

Displays the TCP/IP setting that you specified in the Ethernet communication settings.

▶ Click here.

Timeout (Time Out)

If a connection cannot be established between the WT1800 and the PC within the amount of time specified here, the WT1800 aborts the connection process.
You can set the timeout time to infinity or a value between 1 and 3600.

You must set TCP/IP parameters to connect the WT1800 to an Ethernet network.

▶ Click here.

Notes about Connections

- To connect the WT1800 to a PC, be sure to use straight cables through a hub. Correct operation is not guaranteed for a one-to-one connection using a crossover cable.
- Use one of the following types of network cables that support the data rate of your network.
  UTP (Unshielded Twisted-Pair) cable
  STP (Shielded Twisted-Pair) cable

Clearing Remote Mode (LOCAL)

To clear remote mode, press LOCAL.

▶ Click here.

System Configuration (System Config)

You can specify the following settings.

- WT1800 date and time
- Language
- LCD adjustment
- USB keyboard language
- Environment settings (Preference)
- Crest factor

Date and Time Settings (Date/Time)

The WT1800 date and time.

Turning the Display On and Off (Display)

Set whether to show the date and time on the WT1800.

Method for Setting the Date and Time (Type)

You can set the method for setting the date and time to one of the following options.

- Manual: Set the date or time manually.
- SNTP: Use an SNTP server to set the time (valid when Ethernet communication is being used).

Date and Time (Date/Time)

This setting is valid when the method for setting the date and time is set to Manual.
Set the date and time.

- Setting the date
  The format for setting the date is YYYY/MM/DD (year/month/day). Set the year using the last two digits of the year according to the Gregorian calendar.
- Setting the time
  The format for setting the time is HH:MM:SS (hour:minute:second). The hour can be set to a value from 0 to 23.

Setting the Time Difference from Greenwich Mean Time (Time Difference From GMT)

This setting appears when the method for setting the date and time is set to SNTP.
Set the time difference between the region where you are using the WT1800 and Greenwich Mean Time to a value within the following range.
-12 hours 00 minutes to 13 hours 00 minutes
For example, Japan standard time is ahead of GMT by 9 hours. In this case, set Hour to 9 and Minute to 00.

Checking the Standard Time

Using one of the methods below, check the standard time of the region where you are using the instrument.

- Check the Date, Time, Language, Regional Options on your PC.
- Check the standard time at the URL on the right.http://www.worldtimeserver.com/

- The WT1800 does not support Daylight Savings Time. To set the Daylight Savings Time, reset the time difference from Greenwich Mean Time.
- Date and time settings are backed up using the internal lithium battery. They are retained even if the power is turned off.
- The WT1800 has leap-year information.
- The Time Difference From GMT setting is shared with the same setting found in the SNTP settings in the Ethernet communication (Network) settings. If you change this setting in the date and time settings, the Time Difference From GMT in the Ethernet communication (Network) settings also changes.

Language (Language)

Set the language that is used in the setup menus and messages.

Menu Language (Menu Language)

You can choose to display menus using one of the following languages.

- English
- Japanese
- Chinese
- German

Message Language (Message Language)

Error messages appear when errors occur. You can choose to display these messages and the help using one of the following languages. The error codes that accompany error messages are the same for all languages. For details about error messages, see appendix 6 in the getting started guide, IM WT1801-03EN.

- English
- Japanese
- Chinese
- German

- Even if you set the menu or message language to a language other than English, some terms will be displayed in English.
- You can specify different menu and message languages. However, you cannot set Japanese and Chinese to the menu language and the message language at the same time. For example, if you specify Japanese as the menu language and Chinese as the message language, the menu language will also be set to Chinese.

Adjusting the LCD (LCD)

You can turn off the LCD and adjust its brightness.

Turning Off the LCD (LCD Turn OFF)

You can turn off the LCD. When the LCD is off, you can turn it back on by pressing a key.

Automatically Turning Off the LCD (Auto OFF)

The LCD turns off automatically when there are no key operations for a given time period. The LCD turns back on when you press a key.

Auto Off Time (Auto OFF Time)

You can set the time after which the LCD turns off automatically to a value within the following range.
1 min to 60 min

Adjusting the Brightness (Brightness)

You can set the brightness to a value from 1 (darkest) to 10 (brightest). You can prolong the LCD service life by decreasing the LCD brightness or by turning off the LCD when you do not need to view it.

Display Color (Color Settings)

- **Graph Colors (Graph Color)**

  You can choose the colors that are used to display the data in the waveform, trend, and vector displays from the following options.
  - Default (Default)
    CH1 to CH16 are displayed with different colors.
  - Classic (Classic)
    The color scheme is the same as that of the WT1600. Some channels from CH1 to CH16 share the same color.

The display data that corresponds to CH1 to CH16 in the waveform, trend, and vector displays is indicated below.

	Waveform Display	Trend Display	Vector Display
CH1	U1	T1	U1
CH2	I1	T2	I1
CH3	U2	T3	U2
CH4	I2	T4	I2
CH5	U3	T5	U3
CH6	I3	T6	I3
CH7	U4	T7	U4
CH8	I4	T8	I4
CH9	U5	T9	U5
CH10	I5	T10	I5
CH11	U6	T11	U6
CH12	I6	T12	I6
CH13	Speed/Aux1	T13	—
CH14	Torque/Aux2	T14	—
CH15	—	T15	—
CH16	—	T16	—

- **Grid Intensity (Grid Intensity)**

  You can set the grid intensity to a value from 1 (darkest) to 8 (brightest).

- **Menu Background Color (Base Color)**

  You can set the background color of the menu to Blue or Gray.

USB Keyboard Language (USB Keyboard)

Select the USB keyboard language to use when entering file names, comments, etc. You can use the following keyboards conforming to USB Human Interface Devices (HID) Class Ver. 1.1.

- English: 104 keyboard
- Japanese: 109 Keyboard

For details on how the WT1800 keys are mapped to the keys on a USB keyboard, see appendix 7 in the getting started guide, IM WT1801-03EN.

Environment Settings (Preference)

Display Digits (Resolution)

You can choose to display four digits or five digits of the numeric data. The number of displayed digits for integration measurement functions is fixed at six.

Frequency Display When the Frequency Measurement Is Less Than Lower Limit (Freq Display at Frequency Low)

When the frequency of the input signal is lower than the frequency that the WT1800 can measure, you can choose to display the frequency as “0” or “Error.”

Motor Display When the Pulse Frequency Measurement Is Less Than the Lower Limit (Motor Display at Pulse Freq Low)

When the pulse frequency of the torque or speed input signal is lower than the frequency that the WT1800 can measure, you can choose to display the values of motor evaluation measurement functions as “0” or “Error.”

Separator and Decimal Point When Data Is Saved in ASCII Format (.csv; Decimal Point for CSV File)

When you save data in ASCII format (.csv), you can choose what type of decimal point to use and how to separate the data.

- Period (Period): The decimal point is a period, and the separator is a comma.
- Comma (Comma): The decimal point is a comma, and the separator is a semicolon.

Menu Font Size (Menu Font Size)

You can set the menu font size to Small or Large.

Crest Factor (Crest Factor)

▶ Click here.

D/A Output (D/A Output Items; option)

You can generate numeric data as ±5 V FS DC voltage signals from the rear panel D/A output connector. You can set up to 20 items (channels).

Output Items (Item)

The measurement functions that you select under Function and Element/Σ appear here.

Function (Function)

- You can select any of the measurement functions listed under “Items That This Instrument Can Measure.”
  ▶ Click here.
- To output integrated values through D/A conversion, set the rated time of integrated D/A output.
  ▶ Click here.
- You can also choose not to output a measurement function (None). The output for channels that have been set to none is 0 V, because they have no corresponding numeric data.
- When the D/A output range mode is set to Fixed, the D/A output of channels whose measurement function has been set to Z, Rs, Xs, Rp, Xp, or F1 to F20 is Fixed at 0 V. When the range mode is set to Manual, the channels produce voltages.

Element (Element/Σ)

- You can select the element/wiring unit from the choices below. The available options vary depending on the installed elements.
  Element1, Element2, Element3, Element4, Element5, Element6, ΣA, ΣB, and ΣC
- If an element in the selected wiring unit does not exist, because there is no data, the output is 0 V. For example, if elements are assigned to ΣA but not to ΣB, the output for the measurement function for ΣB is 0 V.

Order (Order; option)

When you select a function that has harmonic data, you can set the displayed harmonic order within the following range.
Total (Total value) or 0 (DC) to 500

The orders that can be specified vary depending on the measurement function. For details, see “Harmonic Measurement Function Orders.”
▶ Click here.

The outputs of orders that exceed the maximum measurable order are 0 V. For information about the maximum measurable harmonic order, see “Maximum Harmonic Order to Be Measured (Max Order).”
▶ Click here.

D/A Output Range Mode (Range Mode)

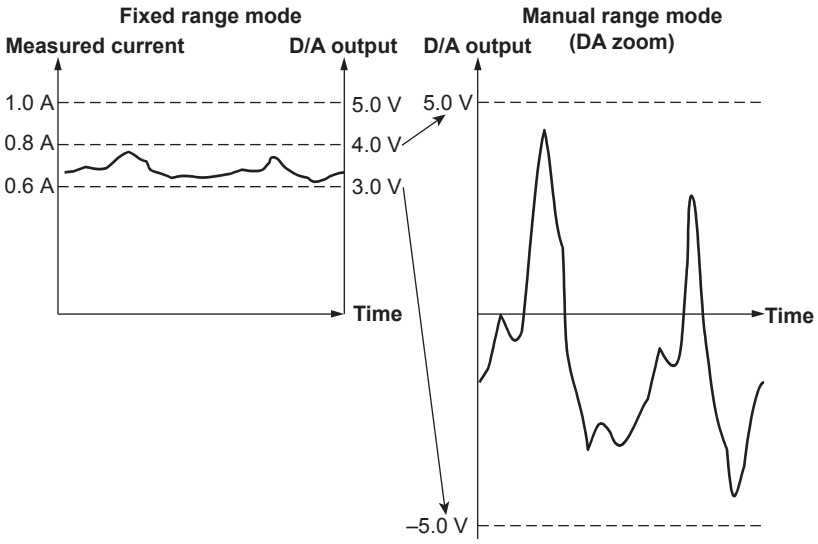
You can select the D/A output range mode from the following options.

Fixed (Fixed range mode)

When a measurement function’s rated value is received, +5 V is output. For details, see “Relationship between Output Items and the D/A Output Voltage.”
▶ Click here.

Manual (Manual range mode)

You can set which measurement function values result in a D/A output of -5 V, and which result in a D/A output of +5 V.
By doing so, you can enlarge or reduce (zoom) the D/A output of each channel. For example, if you are measuring a current that fluctuates between 0.6 A and 0.8 A with a measurement range of 1 A, when the D/A output range mode is Fixed, the D/A output voltage will fluctuate between 3.0 V and 4.0 V. When you want to observe the fluctuations more closely, you can use the D/A zoom feature. If you set the D/A output range mode to Manual and set the minimum value to 0.6 and the maximum value to 0.8, the WT1800 will produce –5 V when the measured current value is 0.6 A and +5 V when the measured current value is 0.8 A.



Maximum (Max) and Minimum (Min) Range Values

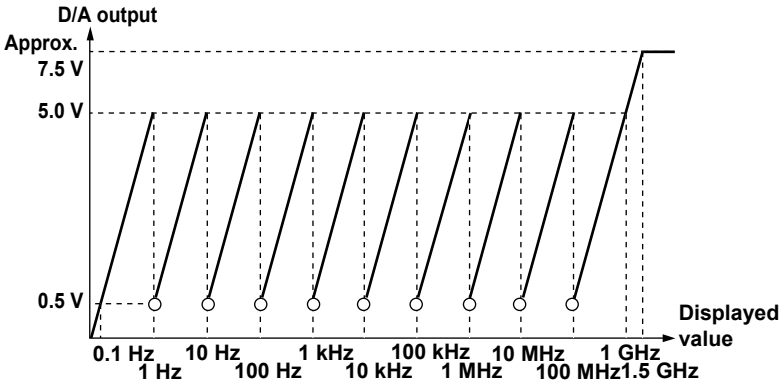
When the range mode is Manual, you can set the maximum (Max) and minimum (Min) values within the following range.

–9.999 T to 9.999 T

- The output is 0 V if a measurement function is not selected or if there is no numeric data.
- If a scaling factor such as a VT ratio, CT ratio, or power coefficient is applied to a voltage, current, or power value and scaling is enabled, the WT1800 produces 100% output (5 V) when the scaled measured value is the same as the scaled rated value (measurement range × scaling factor).
- For Σ functions, the WT1800 produces 100% output (5 V) when the measured value is equivalent to the value that is measured when all of the elements in the group are at their rated values. When the elements have different scaling factors, the WT1800 produces 100% output (5 V) when the scaled measured values are the same as the scaled rated values (measurement range × scaling factor).

Relationship between Output Items and D/A Output Voltage

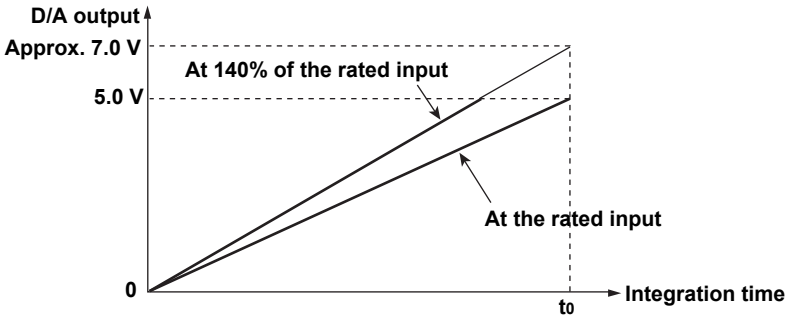
Frequency (the figure is simplified)



User-Defined Events

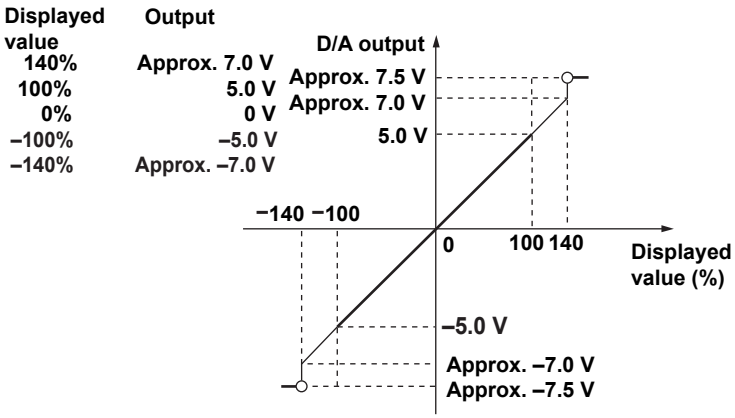
- When the event is occurring (True): +5 V
- When the event is not occurring (False): 0 V

Integrated Values



t0: The rated time of integrated D/A output in manual integration mode.
The timer time in normal or continuous integration mode.

Other Items



- The outputs for λ, Φ, EaU, and EaI do not exceed ±5 V. When the display format of Φ is set to 360 degrees, the output for Φ ranges from 0 V to +5 V. When the display format of Φ is set to 180 degrees (lagging 180° to leading 180°), the output for Φ ranges from –5 V to +5 V. However, when an error occurs, the output is approximately 7.5 V. Only the outputs for U–pk and I–pk are approximately –7.5 V when an error occurs.
- The outputs for η^1 to η^4, Uhdf, Ihdf, Phdf, Uthd, Ithd, Pthd, Uthf, Ithf, hvf, hcf, and Slip* are +5 V at 100%.
- The outputs for Utif and Itif are + 5 V at 100.
- The output for an analog torque signal is +5 V when the torque reaches the value of the input range × the torque scaling factor × the input signal slope (this is the rated value).[1] For example, when the input range is 10 V, if the scaling factor is set to 1 N•m of torque per 1 V of input voltage, the output is +5 V when the torque is 10 N•m.
- The output for an analog rotating speed signal is +5 V when the rotating speed reaches the value of the input range × the revolution scaling factor × the input signal slope (this is the rated value).[1] For example, when the input range is 10 V, if the scaling factor is set to 100 rpm per 1 V of input voltage, the output is + 5 V when the rotating speed is 1000 rpm.
- The output for a pulse rotating speed signal is –5 V when the rotating speed reaches the value specified for Pulse Range Upper × –1 (this is the rated value), and the output is +5 V when the rotating speed reaches the value specified for Pulse RangeUpper.[1]
- The output for a pulse torque signal is –5 V when the torque reaches the value specified for Pulse Range Upper × –1 (this is the rated value), and the output is +5 V when the torque reaches the value specified for Pulse RangeUpper.[1]
- The output for SyncSp is +5 V when SyncSp is at the rated value for Speed.[1]
- The output for Pm is +5 V when Pm reaches the motor output value obtained from the rated values for the torque and rotating speed.[1]
- The output for Aux1 or Aux2 is +5 V when Aux1 or Aux2 reaches the value of the input range × the scaling factor for Aux1 or Aux2 × the input signal slope (this is the rated value).[2]

1 Speed and torque waveforms are available on models with the motor evaluation option.
2 Aux1 and Aux2 waveforms are available on models with the auxiliary input option.

Self-Test (Selftest)

You can test the keyboard and memory operations.

Test Items (Test Item)

You can perform the following tests.

Memory Test (Memory)

You can test the internal memory to determine whether it is functioning normally. If “Pass” is displayed, it is functioning normally. If an error occurs, “Failed” appears. After the test is completed, “Test Completed” appears.

Key Test (Key Board)

- Tests whether or not the front-panel keys are operating properly. If the name of the key that you press is displayed, the key is operating properly.
- If the indicators on the front panel turn on and off in order when you press the left and right cursor keys, they are operating properly.
- To exit the key test, press ESC twice.

Keyboard Test (Soft Key)

This test appears when you set Test Item to Key Board. You can test whether the keyboard displayed on the screen is functioning properly. If the characters that you type appear correctly in the keyboard’s input box, the keyboard is functioning properly.

Executing a Test (Test Exec)

The selected self-test starts.

If an Error Occurs during a Self-Test

If an error occurs even after you perform self-tests numerous times, contact your nearest YOKOGAWA dealer.

23 Other Features

You can set the following items.

- Zero-level compensation (CAL)
- NULL feature (NULL SET)
- Enabling and Disabling the NULL Feature (NULL)
- Clearing Remote Mode (LOCAL)
- Key lock (KEY LOCK)

Zero-Level Compensation (CAL)

Zero-level compensation is the process of creating a zero-input condition using the WT1800 internal circuit and setting the level at that point to the zero level. It must be performed to meet the specifications of this instrument.

- Pressing CAL executes zero level compensation.
- The WT1800 automatically performs zero-level compensation after you change the measurement range or input filter.

- To make accurate measurements, we recommend that you execute zero-level compensation after warming up the instrument for at least 30 minutes. Also, the ambient temperature should be stable and within the specified range (see chapter 6 in the getting started guide, IM WT1801-03EN).
- If the measurement range and input filter remain the same for a long period of time, the zero level may change due to the changes in the environment surrounding the WT1800. If this happens, we recommend that you execute zero-level compensation.
- There is a feature that automatically performs zero-level compensation during integration (integration auto calibration).

▶ **Click here.**

NULL Feature (NULL SET)

You can use the NULL feature to subtract the DC offset while a measurement cable or external sensor is connected.

Items to Configure NULL Settings for (Target Element)

All

Each time you press NULL, you can enable or disable the NULL feature for all the following input signals.

- U and I signals of each element
- Speed and Torque signals (on models with the motor evaluation option)
- Aux1 and Aux2 (on models with the auxiliary input option)

Select

Press NULL to select the input signals that you want to enable, hold, or disable the NULL feature for.

Voltage (U)

- All: You can enable or disable the NULL feature for the voltage signals of all elements at the same time.
- U1 to 6: You can enable or disable the NULL feature for the voltage signals of each element separately.

Current (I)

- All: You can enable or disable the NULL feature for the current signals of all elements at the same time.
- I1 to 6: You can enable or disable the NULL feature for the current signals of each element separately.

Motor (Motor)

- All: You can enable or disable the NULL feature for the Speed and Torque signals at the same time.
- Speed, Torque: You can enable or disable the NULL feature for the Speed and Torque signals separately.

Auxiliary Input (Aux)

- All: You can enable or disable the NULL feature for the Aux1 and Aux2 signals at the same time.
- Aux1, Aux2: You can enable or disable the NULL feature for the Aux1 and Aux2 signals separately.

NULL Status (Status)

Enable or disable the NULL feature for each input signal

- ON: When you press NULL, the WT1800 sets or updates the NULL value. Afterwards, the NULL value is used to correct the measurement function values.
- Hold: The function of this key varies depending on whether the NULL value has yet to be set or has already been set.
  - When the NULL value has yet to be set
    When you press NULL and enable the NULL feature, the WT1800 sets the NULL value. Afterwards, the NULL value is used to correct the measurement function values. If you press NULL again, the NULL feature is disabled, but the WT1800 saves the specified NULL value.
  - When the NULL value has already been set
    Even if you press NULL and enable the NULL feature, the NULL value is not updated. The saved NULL value discussed above is used to correct the measurement function values.

  For example, if you turn on the power and then immediately enable the NULL feature, the NULL value has not yet been set, so the value measured then is used as the NULL value. If you press NULL again afterwards, the NULL feature is disabled. The WT1800 saves the NULL value. Even if you press NULL and enable the NULL feature, the NULL value is not updated. The saved NULL value discussed above is used to correct the measurement function values.
- OFF: Even if you press NULL, the NULL feature is not enabled. Measurement function values are produced with no NULL correction.

The held NULL value is cleared under the following circumstances.

- Operations that cause the NULL values of all inputs to be cleared
  - Turning on the power (the NULL values are not backed up when you turn off the power)
  - Initializing the settings
  - Loading a setup data file
- Operations that cause the NULL value of the input whose settings were changed to be cleared
  - Switching between direct current input and external current sensor input
  - Changing the Sense Type setting for the Speed or Torque motor evaluation input signal

NULL Values

When you enable the NULL feature, the following measurement values are used as the NULL values.

- Udc and Idc (the voltage and current simple averages)
- Speed and Torque signals (on models with the motor evaluation option)
- Aux1 and Aux2 (on models with the auxiliary input option)

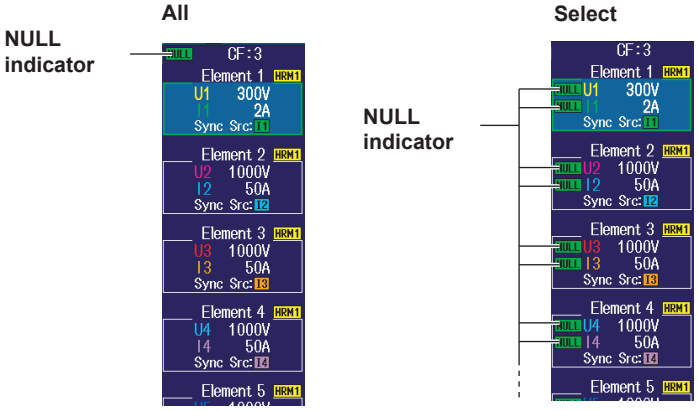
Measurement Functions Affected by the NULL Feature

All measurement functions are affected by the NULL values.

- If there are no previously measured values for Udc, Idc, Speed, Torque, Aux1, or Aux2, because for example the NULL feature has been turned on before any measurements have been made, the NULL values are set to zero.
- For measurement functions that are computed based on an element's voltage and current values, the NULL values are subtracted from the sampled voltage and current values.
- For motor evaluation measurement functions and auxiliary input measurement functions, the NULL values are subtracted from the computed numeric data.

Enabling and Disabling the NULL Feature (NULL)

- Enable the NULL feature. The NULL key illuminates. The NULL indicator illuminates as described below depending on how the Target Element setting has been set.
  - All: The NULL indicator illuminates in the upper right of the screen.
  - Select: The NULL indicator illuminates to the left of the element, motor or AUX inputs, which are located on the right side of the screen.



- If you press NULL while the NULL feature is enabled, the NULL key light and NULL indicators turn off, and the NULL feature is disabled.

- To make accurate measurements, we recommend that you execute zero-level compensation before enabling the NULL feature.
- The NULL feature is disabled when:
  - The power is turned on.
  - The settings are initialized.
  - A setup data file is loaded.
  - You switch between direct current input and external current sensor input.
  - You change the Sense Type setting for the Speed or Torque motor evaluation input signal.
- If the NULL feature is enabled or disabled while the display is held, the NULL indicator will illuminate or turn off, but the held data will not be affected. Also, the NULL indicator will be highlighted.
- The DC values that the NULL value is based on when the NULL feature is ON are held, but the upper limit of the NULL value is ±10% of the range when the crest factor is set to CF3. The upper limit of the NULL value is ±20% of the range when the crest factor is set to CF6.
- When the range is changed, the NULL value upper limit will be determined by the new range. The NULL value upper limit will also be adjusted when the range is decreased by the auto range feature.

Clearing Remote Mode (LOCAL)

Use this key to switch from remote mode (the REMOTE indicator will illuminate) to local mode (in which front panel key operations are valid). This key is invalid when the WT1800 is in local lockout mode.

Key Lock (KEY LOCK)

When you enable the key lock, the WT1800 behaves as described below. You can use the key lock to prevent unintentional operations.

- All key operations are disabled except for those of the power switch and SHIFT+LOCAL (KEY LOCK).
- The key lock indicator (“LOCK”) appears in the upper right of the screen.

The key lock remains on or off even after the power is turned off.

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